DEVELOPMENT OF EDUCATIONAL PROGRAMS FOR ENVIRONMENTAL RESTORATION/WASTE MANAGEMENT AT TWO DEPARTMENT OF ENERGY SITES

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ABSTRACT

Availability of appropriately educated personnel is perhaps the greatest obstacle faced by the nation in addressing its waste management and environmental restoration activities. The U.S. Department of Energy (DOE) Idaho National Engineering Laboratory (INEL) and the DOE Grand Junction, Colorado, Projects Office (GJPO) have developed two educational degree programs that respond to the human resource needs of the environmental restoration/waste management effort in ways that reflect the programmatic and cultural diversity at the two sites. The INEL has worked with the University of Idaho and Idaho State University to develop a set of master's degree programs focusing on waste management and environmental restoration. GJPO has developed an associate degree program and is developing a baccalaureate program in environmental restoration with Mesa State College. The development of these two programs was coordinated through the INEL University Relations Committee. They were conceived as parts of an overall effort to provide the human resources for environmental restoration and waste management. The background, need, and development of these two programs are presented, as well as information on associated industry partnerships, employee scholarship programs, and plans for integration and articulation of curricula.

INTRODUCTION

The Department of Energy (DOE) Division of Technology Integration and Environmental Education, under the Office of Environmental Restoration and Waste Management, Office of Technology Development was established in fiscal year 1990. The general function of the education component of the Division is to assist the development of educational programs and partnerships aimed at increasing the number of scientists, engineers, and other professionals needed to resolve the DOE's environmental restoration and waste management (ER/WM) challenges. The DOE Environmental Restoration and Waste Management Five-Year Plan states, "To achieve its vision for this program, DOE must compare internal and external human resource needs against the current resource base and take innovative steps to develop, motivate, and allocate needed resources." [1]

DOE has stated in its planning with EPA and other regulators that it will accomplish the massive Environmental Restoration/Waste Management Program in about 30 years from 1990. This program can be likened to the Manhattan Project and the early NASA space programs in the sense that large infusions of federal funding are required to sponsor the development of the necessary technology as well as to develop appropriate human resources.

While the Manhattan Project and the early NASA programs were comparatively narrow in terms of technical objectives and well defined in terms of personnel educational discipline needs, the Environmental Restoration/Waste Management Program is broad and still not completely defined. Regardless of the final scope, the ER/WM task at hand is immense -- estimated in the hundreds of billions of dollars over the next few decades.

MANPOWER AND EDUCATIONAL NEEDS

The above funding levels translate into a need for tens of thousands of new technicians, technologists, engineers, and scientists. With such an ambitious buildup, an increasingly serious shortage of scientists and engineers to do the environmental cleanup work will be encountered. How is DOE to meet is manpower needs? To answer this question, two corollaries to the question must first be answered. First, what are the scientific, engineering, and technical disciplines required to meet the challenges of this projected effort? Second, do all of the necessary disciplines currently exist? To assist in answering these questions it is necessary to consider estimated manpower projections in terms of numbers and disciplines.

A recent report by the Oak Ridge Associated Universities estimates that the current DOE ER/WM Program will increase by 50 to 70% by 1995 [2]. This represents an increase of some 5,000 to 8,000 new personnel, not including the additional personnel required to replace those lost by attrition from the current work force. Extending these estimates to the rest of the federal government, as well as to state and local governments and industry, this number could easily increase by a factor of 3 to 5.

Most of the DOE site cleanups of significance will probably follow the cleanup protocol of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, because these sites will either be listed on the Superfund National Priorities List or will be assigned CERCLA protocol through an interagency

agreement with the Environmental Protection Agency and/or the state. The CERCLA protocol is such that the initial or predecisional phases, remedial investigation and feasibility study (RI/FS), require heavy participation of the scientific and engineering disciplines. The RI/FS culminates in a Record of Decision, which defines the remedial action. It is important to note that the manpower requirement differences of the postdecisional phases, remedial design and remedial action (RD/RA), are not yet fully understood by the sites currently in the predecisional phases. The RD/RA will be treated more like a construction project with the associated construction and project management culture and will require less involvement of scientists and engineers. How the need has been perceived differently by the two sites and how that need has affected the development of educational programs will be discussed herein.

INEL Manpower Needs Projection

The INEL is located on 890 square miles of Southeastern Idaho. More than 11,000 employees work for several contractors under the management of the DOE Idaho Operations Office. Its primary mission is applied research programs. The INEL is one of the DOE sites facing a large environmental cleanup and compliance effort. It is only natural to expect that the INEL will approach this set of problems in the same way it has successfully approached other problems. The application of state-of-the-art technology to stated needs is what the INEL does best and can be said to be its culture.

The INEL Mission with respect to ER/WM activities is threefold: environmental restoration of site locations, management of stored and newly generated wastes, and research and development of new technologies to be applied in the first two areas. The INEL emphasizes the development and application of new technologies and the management of new programs. Since the INEL, like most other DOE sites, is early in the predecisional phases and has a culture that emphasizes research and development, its recognizable human-resource needs are in the basic and applied scientific and engineering disciplines, drawing heavily upon personnel with postgraduate credentials.

The INEL is early in the process that will identify ER/WM activities, develop plans and budget estimates for these activities, and compete with other priorities for funds for these activities. Thus, any estimates made on future manpower levels are laden with caveats; however, best estimates were made based on a detailed survey of management within EG&G Idaho, the largest site contractor at the INEL [3]. Since EG&G Idaho has responsibility for the majority of ER/WM activities at the INEL, these data are extrapolated here, assuming somewhat similar mixes in the other INEL contractors and that three quarters of the ER/WM activities at the INEL are performed by EG&G. With these assumptions, it is estimated that INEL will require at least 800 new ER/WM personnel by FY 1995, provided competition for manpower does not drastically increase attrition rates. Of this projected total, about one- third of personnel requirements are deemed immediate within FY 1991. Table I provides these estimates by educational degree level.

TABLE I
INEL Projected ER/WM Manpower Needs by Degree Level

Degree Level	Current Needs	Five-Year Needs
Pre-Baccalaureate	60	140
Baccalaureate	95	265
Master's	120	305
Doctorate	20	100

From the estimates in Table I, it can be seen that at least 80% of INEL ER/WM manpower needs by FY 1995 will require at least a four-year college education, and that 50% will require significant education beyond the baccalaureate degree level. In lieu of the availability of appropriately degreed personnel, INEL managers estimate that about one-half of manpower requirements at the baccalaureate level and above could be met by standard B.S. degrees augmented by specific advanced educational training from internal sources or by university graduate level courses. The INEL opted to accomplish this goal by establishing master's-level degree programs through the University of Idaho and Idaho State University.

With respect to preference of discipline, the manpower survey further showed a 40:30:30 ratio between interdisciplinary (non-specific), engineering, and science masters degrees, respectively. The high demand for interdisciplinary masters degrees stems from the large need for experienced personnel in ER/WM fields where individuals must have a broad knowledge base that includes environmental science, hazardous waste management, radioactive waste management, and regulatory issues. Of prime interest in the engineering disciplines were chemical engineers with an emphasis in environmental science, mechanical engineers and environmental engineers. In the sciences, chemistry and geology/hydrology showed the highest demands.

GJPO Response to DOE Needs

The GJPO is located in Grand Junction, Colorado, and reports administratively to the DOE Idaho Operations Office (DOE-ID). The DOE Manager of the GJPO reports to the Manager of the DOE-ID Environmental Restoration

Division. Environmental restoration has been the primary mission of the GJPO for about 10 years. Several remedial action projects, most involving removal of uranium mill tailings, have been managed through the GJPO. Some of the first Records, of Decision toward environmental restoration in the DOE system were accomplished at the GJPO in fiscal year 1990. Although the GJPO conducts some applied research and possesses substantial scientific and engineering experience used in the predecisional phases of environmental restoration, the bulk of its experience has been in the post-decisional environmental restoration phases; thus, the culture at the GJPO is a pragmatic one of project and construction management.

Although the GJPO has specific human resource needs, the educational programs at the GJPO were developed to respond to DOE system-wide needs as stated in the Five-Year Plan. Ten years of environmental restoration experience might qualify the GJPO as an accurate "bench-scale test" for the whole DOE Environmental Restoration Program. The difference between environmental restoration and waste management is well understood at the GJPO. Environmental restoration has the scope, funding, and deadlines of a construction project while waste management is managed as a process. Since the environmental restoration programs performed at the GJPO have normally involved immediate use of off-the-shelf technology and have had tightly imposed completion schedules, innovative technology has not been a strategic priority. Innovative tools have been developed in the tactical sense to get the job done. Human resources required at the GJPO reflect this hands-on pragmatism with emphasis on associate and baccalaureate degrees.

An erroneous assumption often made in the environmental cleanup business is that comprehensive characterization will furnish data accurate enough for the ensuing design to control a well-identified construction project. However, the subterranean nature of the sites to be remediated implies a substantial degree of uncertainty for characterization and makes remedial design more of a functional guideline that an accurate specification. Much of the characterization which finally defines the remedial action is performed as the remedial action progresses. This requires people in that process with the background to understand the guidelines and who can communicate and think independently.

At the GJPO, it was noticed over a period of time that there was significant personnel turnover in technological positions that included routine tasks such as the performance of practical design procedures, field supervision, documentation, and data gathering. These tasks were found to be generally too difficult for most high school graduates and too elementary for graduate engineers and scientists. Thus, the first indication of need at GJPO was based on practical experience.

DEVELOPMENT OF EDUCATIONAL PROGRAMS

INEL Waste Management Masters Program

Based on the INEL ER/WM manpower projections derived from the survey of managers, a decision was made to pursue the development of Masters Degree Programs in a cooperative venture between the INEL, the State Board of Education and with two of the State's Universities, the University of Idaho and Idaho State University. Both universities already offer graduate curricula to the INEL through the Idaho Falls Center for Higher Education (IFCHE). The State Board of Education took a keen interest in meeting the perceived educational needs and actively assisted in coordinating the development of the programs.

The goal was to develop a range of degree offerings to meet the variety of required disciplines identified in the survey. With the needs defined, the universities rapidly developed programs that could meet a majority of the requirements. The array of degrees already available at the INEL through IFCHE served as an excellent base from which to start. By extending additional degree options from the respective campuses through IFCHE, and then developing a number of new courses specifically aimed at hazardous waste management, radioactive waste management, environmental sciences, and regulatory requirements, the universities were able to offer the array of degrees shown in Table II. Extremely important to this process, the Board of Education enabled the new programs by accelerating its normal curriculum approval process, so that the initial offerings under this effort were available a scant six months after the cooperative effort began.

TABLE II
ER/WM-Oriented Master's Degrees Offered Through the Idaho Falls Center of Higher Education

Discipline	Univ. Idaho	ISU
Chemical Engineering	M.S., M.E.	
Civil Engineering	M.S., M.E.	
Mechanical Engineering	M.S., M.E.	
Metallurgical and Mining Engineering	M.S., M.E.	
Interdisciplinary Studies	M.S., M.E.	M.S.
Nuclear Science and Engineering		M.S.
Measurement and Control Engineering		M.S.

Note that the resultant program is a combination of conventional engineering degrees and interdisciplinary degrees with an emphasis in waste management and environmental restoration. Students qualify for the emphases by selecting at least three courses from the array of new courses specially developed for the program. (Students supported under the EG&G Sponsorship Program are required to take six courses plus a seminar.)

Waste management courses, as well as the normal curriculum offerings, are taught both by university staff and INEL employees. Classes are held primarily at IFCHE, which is near DOE and INEL contractor offices in Idaho Falls. A combination of live classes, televised live classes, and videotaped classes is used to make course offerings available both at IFCHE and on campus, where the same curricula are offered to students in residence at the respective universities. Regular university students, INEL employees and individuals from the local community are all eligible to participate in the program. INEL employees may participate in the program through one of several employee education options, including full-time employee scholarships, which are described below.

While initiated by INEL, and while INEL is supporting a major portion of the start-up costs for the program, the State and its universities plan to make the program largely self-supporting in the next few years. Because of this support and emphasis by the INEL, most of the students enrolled in the program are INEL employees; however, the program is open to the community at large, and a number of non-INEL employees are enrolled in some of the university degree programs.

GJPO Environmental Restoration Technology Associate Program

The indication of a direction for human resource development at GJPO was made obvious through the hiring by Geotech of a person with an Associate Degree in Civil Engineering Technology. The science and technical background was not exactly appropriate, but the independent thought process and the technical communication skills were there. His level of education allowed him to be challenged and content in the day-to-day practical tasks. It was seen that such persons in remedial design/remedial action could augment the scientists and engineers available, helping to relieve the inevitable shortage.

Because Mesa State College had an existing associate degree program in Civil Engineering Technology and had been cooperating for some time with GJPO to provide education in technological areas, they were approached with the idea of providing a curriculum for an associate degree program in environmental science. Curriculum and course development took place in 1988 and 1989. Pilot courses were taught in the Fall of 1989 and Spring of 1990 with encouraging success. The curriculum for an Associate Degree Program in Environmental Restoration Technology was submitted to the State of Colorado approval processes in early 1990 and was given full approval in August 1990. The program provides basic math/science background, technical communications skills, and knowledge of industry work process, culture. and vocabulary. Teaching is jointly done by Mesa State and GJPO personnel as a transitional stage toward full teaching by Mesa State.

In the Mesa State College program the distinction is made between environmental restoration and waste management. The definition of waste management as the development and operation of processes and technology appropriate to managing existing waste streams in compliance with environmental law and regulations was considered as already being represented fairly in university and college programs, especially in two-year programs. Existing technical engineering and science disciplines such as wastewater treatment and process chemistry have formed the basis for curriculum and staff for many waste management programs. Environmental restoration certainly has a component of waste management included in the sense of waste treatment, transportation, and storage, but its emphasis is on the comparatively short- term goal of restoring existing waste sites and on the concepts of the construction project.

The distinction is also made between technicians and technologists. Webster's Ninth Collegiate Dictionary defines technology as "applied science, a scientific method of achieving a practical purpose." A technician is defined as "a specialist in the technical details of a subject or occupation". A technologist is merely defined as "a specialist in technology". The program at Mesa State College provides background in mathematics and science, in technical communication, and in technology as applied to environmental restoration. The intent is that the technologist will be a generalist in performing practical engineering and scientific tasks.

The GJPO/Mesa State College/AT&T Alliance

The initial partners, the GJPO and Mesa State College, sought and were granted start-up funding from DOE Division of Technology Integration and Environmental Education. A coincidental inquiry focused AT&T's attention on the emerging educational program. AT&T's university outreach people were looking for innovative educational programs that would utilize their equipment for computer-aided instruction (CAI). Successful application and negotiation brought AT&T's grant to more than $850K. At the formal program announcement and press release in August of 1990, AT&T shared the dais with representatives from DOE-HQ, DOE-ID, State of Colorado, and Mesa State College.

The Colorado Governor's Job Training Office, other computer software companies, and other Colorado industries have also joined the alliance, bringing the total contributions to approximately one million dollars.

SCHOLARSHIP AND FELLOWSHIP PROGRAMS

With curricula in place, an effort was made at both the INEL and GJPO to find means of providing midcareer education for existing personnel. Both sites chose sponsorships, or employee scholarships, as a means of placing existing employees into the new degree programs.

INEL Sponsorship Programs

The INEL offers an array of continuing education opportunities to employees. Most include options for pursuit of degrees on a part-time basis, which requires up to several years for completion of some degrees. Since the urgency of the personnel requirement was immediate, new options were called for and were explored.

In one option, EG&G Idaho pioneered the development of employee Sponsorships, which were offered on an experimental basis for the first year of the program. Sponsorships were awarded on a competitive basis, and employees awarded a sponsorship were permitted to take up to two full semesters off with full pay to pursue one of the degrees on a full-time basis. While two semesters are insufficient for employee-students to complete a master's degree, it did much to "jump start" them by encouraging them to focus on ER/WM-related courses initially, along with some of their degree core courses. Upon returning to the work place, they were immediately able to begin using their new education to benefit DOE ER/WM programs. By continuing to use other employee education programs, they will be able to continue their graduate education and to complete the master's degree in a much shorter time frame than previously possible.

During this first year of the Waste Management Master's Degree program, EG&G Idaho has 20 employees in the Sponsorship program, as well as a much larger number through other employee education options. Other Idaho-based INEL contractors are considering offering similar opportunities to their employees.

GJPO Sponsorship Program

At GJPO, five Geotech employees are being sponsored in the Environmental Restoration Technology Associates Program at Mesa State and one employee is being sponsored in the INEL Waste Management Masters Program. They will work half-time and pursue degrees half-time. The Associate Program sponsorships allow three years or six semesters to complete the degree, while the Master's Program sponsorship allows two years or four semesters. Each employee works out a work schedule with his/her supervisor. Through an agreement with Mesa State College, all required courses are offered in an afternoon/evening time frame to accommodate working students.

Directions in Scholarships and Fellowships

The current sponsorship programs are generally working well; however, there are some drawbacks. Sponsorships are available only to existing contractor employees and are not available to the general public. They involve the payment of existing salary for attending school. They involve a low degree of sacrifice on the part of the sponsored employee, and are expensive.

Despite these shortcomings, the sponsorships were deemed necessary for accelerating employee education and for realizing short-term results of the curriculum development efforts. Sponsorships provide excellent incentives for mid-career retraining for existing employees, who are known quantities, but who would likely not be able to afford returning to school full-time for such education. Obviously some balance needs to be struck and the cost of obtaining the education should be shared between the DOE and the individual, as both benefit.

The INEL experiment with Sponsorships is ongoing. Progress will be monitored carefully to identify the effectiveness of the programs. Meanwhile, still other options are being explored. Sponsorships that do not provide for full-time release may be desirable. Additionally, scholarships and fellowships that are available on a competitive basis to the general public may be highly effective for attracting recent graduates to continue their graduate education in ER/WM disciplines. Finally, experiments with flexible work time, as well as other employee education programs, should be explored to assist in making the results of these education programs available as soon as possible.

CONCLUSIONS

The most important conclusion to be drawn from the INEL/GJPO experiences is that many diverse and coordinated educational programs will be needed to fill DOE's human resource needs for its environmental restoration and waste management efforts. The diversity that exists within DOE provides the basis for the development of diverse programs. It will take coordination to provide a coherent picture of the assembly. Communication is always the key to coordination.

Different cultural and programmatic factors have affected the view of the human resources needs at the INEL and the GJPO. The approaches to and development of educational programs at the INEL and the GJPO have been appropriate to each site's respective circumstances and to the needs perceived. Because the INEL is early in the environmental restoration process and because of the INEL applied research and development culture, the appropriate

response has been to develop a set master's degree program in Waste Management. GJPO, because of the weight of its experience in the remedial design and remedial action phases and because of its construction management culture, has chosen to develop an Associate's Degree Program in Environmental Restoration Technology first.

These seemingly incongruous approaches were seen by the developers as initial parts of a comprehensive educational plan and were coordinated through the INEL University Relations Committee.

WHERE DO WE GO FROM HERE?

The upcoming emphasis should be on the development of a comprehensive set of educational programs throughout the DOE complex and the sharing and transfer of those programs to benefit DOE and all of the nation. Alliances of academia, industry, and government will continue to be essential to shorten the response time of education to a rapidly changing world and to get DOE out of the education business.

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