

## RESOURCES OF THE FUTURE IN ENVIRONMENTAL MANAGEMENT

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### ABSTRACT

A major issue facing the generation and application of environmental technology is that of educating and training the work force that is needed to resolve the problems of the past and those for the next few decades. By necessity, this professional level workforce must have multidisciplinary education combined with research experience at the leading edge of technology.

In order to satisfy this critical need, a unique type of organization was created for education and technology development in environmental areas. The Waste-management Education and Research Consortium (WERC) was created in 1990 by a cooperative agreement with the U.S. Department of Energy as a partnership of New Mexico State University, the University of New Mexico, and the New Mexico Institute of Mining and Technology in collaboration with Los Alamos National Laboratory and Sandia National Laboratories; the Navajo Community College joined as an affiliate in 1991. WERC has conclusively demonstrated that such a partnership collaborating with industry can be an effective tool to expand the nation's resources to address issues related to the management of all forms of waste, via education, technology development and information transfer. The WERC program has implemented the following items.

- College education at the technologist, undergraduate and graduate level.
- Pre-college programs to involve young students in environmental activities.
- Professional development and retraining series by satellite TV.
- Technology development projects for solutions at the leading edge.
- Four measurement and testing laboratories.
- Technology transfer for information to communities, industry and government.
- A University Design Contest for interaction between universities.
- A First Response Training Academy for emergency personnel.

Currently this program is serving over 2000 students and professionals on an international bases. WERC has become a model for multidisciplinary, multiorganization environmental education in the world. The very high minority population of New Mexico and of the academic institutions of WERC makes this program a national priority.

The Consortium has received several top awards including "The Outstanding Engineering Achievement Award" from the National Society of Professional Engineers and the "Best Distance Learning Program Award" from Teleconference Magazine.

### ORGANIZATION

Much of the success of this program is attributed to a multiorganizational, multidisciplinary structure that has been set up between the four academic institutions and the two national laboratories, with involvement of industry. While the program is administered by a director at NMSU, the organization is set up from top down as a multiorganizational unit. The strategic direction is provided by an Executive Board made up of all the consortium entities as well as outside directors. The operations are under the WERC Director, as shown in Fig. 1, with all functions and staff functions set up in a matrix manner utilizing leaders from all the consortium members. All education and research activities are carried out by faculty and students of the academic institutes in collaboration with the national laboratory members and industrial partners.

### EDUCATIONAL COURSES

In the first three years, WERC successfully implemented the following educational programs.

1. An undergraduate option and a graduate option or concentration in Environmental Management at the three consortium universities with a major in any field that is accredited and provides the necessary prerequisites. This program reaches over 30,000 students in schools with minority enrollment of 25% - 95%.
2. A master of science in Environmental Engineering program.
3. A two-year Engineering Technology associate degree program in Hazardous & Radioactive materials handling at Carlsbad, New Mexico and a two-year program for Native American students at the Navajo Community College. NCC has about 600 students with a 95% minority enrollment.
4. A professional development and re-training state-of-the-art series presented through interactive satellite video to laboratories, industry, and federal agencies.
5. A capstone design course on environmental process design with competition between universities at an international level.

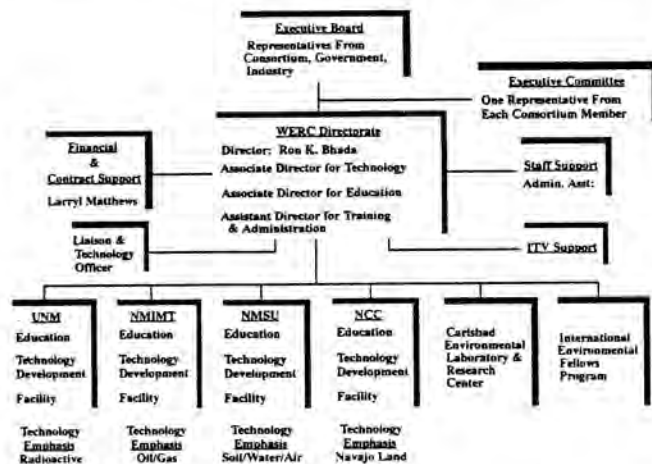


Fig. 1. WERC operational organization.

7. Pre-college programs that interest thousands of students in science and engineering.
8. An International Environmental Fellows Program to provide graduate level education to emerging leaders from government and industry.
9. A Solid-Waste Management degree program for Native American students.

The Consortium's first task in education was to set up the curriculum and establish undergraduate degrees at the Consortium universities in the fields accredited by ABET. This resulted in options leading to a minor in Environmental Management in fall 1990. The core programs necessary to satisfy ABET requirements in each of the disciplines are specified in the catalogs of the respective universities. These core requirements are supplemented by 18-30 hours of courses relevant to waste management, covering not just technology, but also other aspects such as legal, public policy, economics and risk evaluation. Guidelines for the undergraduate minor are shown in Table I.

The graduate program was also established by fall 1990. This program requires the students to take core courses in their chosen discipline, but with approximately one half of their credits in the waste management concentration, including a research thesis or research project in waste management.

The associate degree program was started in fall 1991 in radioactive and hazardous materials technology closely patterned after the accredited engineering technology programs offered on the main campus of NMSU at Las Cruces. An important feature of the curriculum is the high degree of transferability into existing, accredited four-year engineering technology programs. The technology program uses the WIPP facility in conjunction with the New Mexico State University Carlsbad Campus as the training facilities. Graduates of this program are prepared for employment as technicians in industries, laboratories and government agencies.

In fall 1991, a two-year program in environmental science was also started at the Shiprock campus of the Navajo Community College, together with a laboratory for hands-on training. Expansion of this program to solid waste management was implemented in 1992-93; this is expected to have 100 students by the third year.

A major emphasis is to interchange courses between the universities and to transmit the courses throughout the U.S.

TABLE I  
Basic Requirements For The Undergraduate Minor In Environmental Management

- All requirements for a Bachelor's Degree as set by the student's department of registration.
- A minimum of 18 credit-hours of courses from:
  - the "Environmental Management Minor" list,
  - the "Undergraduate Minor" list, and
  - the "Off-Campus Course" list or courses from the ITV offerings.
- The 18 credit-hours include:
  - six credit-hours from the "Undergraduate Minor" list outside of the major undergraduate field,
  - six credit-hours of environmental management courses from outside the student's home university through the WERC-ITV Program or on a student exchange basis, and
  - two credit-hours of Environmental Management Seminar.

and even internationally for re-training needs of human resources. An interactive satellite video system has been set up. The satellite system has been installed and is currently in use for course transmission between the three universities as well as to several other sites. Six to nine different courses have been transmitted each semester since spring 1991.

The degree programs started in fall 1990 at all three universities. The enrollment has grown since the start of the program. The first year's enrollment was 198 and this increased to 471 in the second year, 590 in year three and to 663 in year four. The Consortium has awarded about 80 minor degrees and certificates. Our estimate is that we will be awarding 200-300 degrees with the environmental concentration (or minor) in the first four years of the program, leveling off at about 100 each year.

As part of the effort to introduce a design component and, at the same time, encourage inter-university exchange of information, we have developed and implemented an international university design competition. Universities throughout the United States, Canada and Mexico were invited to compete in the design of a plant for an environmental process and follow this up with a small scale demonstration at a central site. This provided capstone design courses to some universities and, at the same time, brought university students and faculty from diverse parts of America together to exchange information. In 1991, we had seven university teams participating, 15 in 1992, 21 in 1993, and 31 have registered for 1994. The first three years have been fantastic successes in achieving the objectives of design education and information exchange based on feedback from the participants and the judges.

Pre-college education projects (under WERC but funded separately) were also started, including:

1. a summer training course in environmental design for high-school teachers and students;

2. a pilot program on a Los Alamos originated program for student participation called "Students Watching Over Our Planet Earth" (SWOOPE);
3. a project for international water quality monitoring for high-school students;
4. a summer internship program (Project SEED) in cooperation with the ACS; and
5. a project to produce research highlighting results videos to interest pre-college students in environmental discoveries.

#### EDUCATION BY TECHNOLOGY DEVELOPMENT

A very important result of the WERC program is the production of students with advanced degrees in environmental management via hands-on independent technology development projects at the leading edge of technology. This form of education is the focus of our technology development projects.

The scope of the Center's research is broad-based and is designed to include all areas of radioactive, hazardous and solid waste management and environmental restoration. Pro-

jects are selected from proposals submitted by faculty of the academic consortium members with collaboration from the national laboratories and industry. A major emphasis is on teaming between universities, national laboratories and industry researchers.

As a means of facilitating the use of the results for education in a timely manner, special teleconferences are conducted that attract a very wide professional audience. Major conferences on research results are conducted each year that attract a wide audience from throughout the United States.

It is too early to predict the impact of the technology development projects. However, several of the projects are already showing promise for meaningful applications, as shown by the examples in Table II. It is our objective that in the next two years, more commercial applications will result from this program activity. Equally important is the practical experience that about 200 faculty members and students are getting from the involvement in the research projects and the exchange of technology between the universities, the national laboratories and industry.

TABLE II  
Examples of Research Results

- **Building Material From Wastes**

Developed a process for converting fly ash and other wastes (including toxic wastes) to non-toxic building block, in conjunction with TIDE, Inc.

- **Nuclear Waste Repository Ventilation System Studies**

Characterized the effect of salt and simulated severe pressure (tornado) conditions on the structural strength of the filters for design of the WIPP site ventilation system, in collaboration with Los Alamos and Sandia National Laboratories.

- **Treatment of Waters Contaminated with BTX and Heavy Metals Using Tailored Zeolites**

Developed a unique process to modify natural zeolites available in New Mexico for use as adsorbing agents to remove benzene, toluene, xylene, chromium, and lead from contaminated water, in collaboration with Texaco, Inc.

- **Minimization and Remediation of DOE Nuclear Waste Problems Using Selective Actinide Chelators**

Developed effective process using organic chelators for the selective binding of radioactive and highly toxic actinide ions such as plutonium from process waste streams and soils, in collaboration with Los Alamos National Laboratory.

- **Public Opinions and Nuclear Waste Management: Tracking Change Over Time in Public Risk Perceptions**

Nation-wide surveys have assessed the risks perceived from nuclear (and other) technologies, along with measures of beliefs, attitudes, and perceptions leading to communication strategies for DOE and national laboratories.

- **Mobility of Radioactive Colloid Particles in Ground Water**

Developed a remediation technology for removal of radioactive colloids from the soil and ground water at Los Alamos National Laboratory.

- **Enhancement of Solar Photocatalytic Detoxification by Adsorption of Porphyrins onto TiO<sub>2</sub> Substrates**

Developed photosensitizers to enhance destruction of toxic compounds in contaminated waste streams, in collaboration with Sandia National Laboratories.

- **Slurry-Phase Bioremediation of Production Pit Sludges**

Developed and demonstrated technology of microbiological treatment of wastewater and sludges associated with oil production, together with Yates Petroleum.

- **Pipeline Leak Detection system for Oil Spills Prevention**

Developed instrumentation system to monitor petroleum pipelines for evidence of leaking in collaboration with Lynx Petroleum.

### EDUCATIONAL AND TESTING FACILITIES

Four facilities have been set up to assist with the research and education.

1. The Soil-Water-Air Testing Facility (SWAT) at Las Cruces is currently providing analytical services in the areas of toxic and hazardous waste management to faculty and students from the universities and other organizations.
2. The Environmental Radioactive Measurement Laboratory (ERML) has the role of exploratory development and projects on transuranic waste.
3. The Oil-Water Experimental Facility at Hobbs (HOWE) provides for educational, and development related to environmental and waste disposal concerns of the petroleum industry. A field laboratory is also available.
4. The Navajo Drylands environmental Laboratory (NDEL) at NCC provides for environmental education and monitoring by the Native American students in the Shiprock area. This was not part of the original program, but grew out of a need identified for the Native American students in northern New Mexico.

### TECHNOLOGY TRANSFER

The technology transfer function of the Consortium is emphasized throughout the program. Specific activities for technology/knowledge transfer are noted below.

- An Executive Board, an Executive Committee and an Advisory Board composed of representatives from top management of university, national laboratories, government, industrial and environmental organizations have been formed and functioning for the purpose of directing the program.
- Continual dialogue has been started with industry and government agencies via an Industrial Liaison Program, via briefings and via newsletters.
- The educational program is continually transferring knowledge to the hundreds of students, national laboratory and industrial professionals.
- Technology development results are being transferred via seminars and via formal contact with participants from industry and government. Results from each funded project are reported each quarter. The fiber optic communication network and the satellite link are used for wide communication of the results.
- Professional development teleconference series have been completed each year on topics of interest to participants from government and industrial organizations. These series are transmitted via the satellite system throughout the U.S. Two new series, one on Risk Assessment and another on Hazardous Waste Management were presented in 1993.
- Over 100 technical papers have been presented and published.

- A number of organizations have joined the Consortium's Industrial Affiliation Program and the program is being expanded to others.

### OUTREACH

Four significant outreach activities have started in 1992-93. These are as follows.

1. An Environmental Fellows Program has been initiated to train emerging leaders from industry and government. Major international conferences, with university, national laboratories and industry experts, are part of this program. Currently ten Fellows from Mexico have started.
2. A major new effort called the Carlsbad Environmental Monitoring & Research Center (CEMRC) has been started at the request of the Carlsbad community for environmental monitoring of the Carlsbad, New Mexico area. This community is located near the Waste Isolation Pilot Plant (WIPP) facility which is planned as a repository for transuranic (TRU) wastes. An independent group has been formed to do complete monitoring the area (flora, fauna, etc.). This group generates the data using state-of-the-art techniques and conducts research on monitoring techniques.
3. A solid waste management educational program has been started at NCC which will provide associate degree education to 100 Native American students annually. A laboratory has been set up for environmental monitoring around the Shiprock area. Students and faculty gain hands-on experience.
4. A first-response, hazardous incident training program has been initiated for emergency response personnel.

In addition, the education outreach has been extended with addition of a new MS in Environmental Engineering degree program.

### AWARDS

The program less than four years old but has been so successful as to receive the following awards that are usually received only by long-established programs.

1. An award to the overall WERC program was presented by the National Society of Professional Engineers as an "Outstanding Engineering Achievement" for 1991.
2. The WERC Teleconference series was presented an award for the "Outstanding Distance Learning Program" by the *Teleconference Magazine* in 1992 and 1993.
3. The WERC program has been nominated for the National Technology Medal in 1993.