

Development of the Masters of Science Degree in Environmental Management and Engineering at the Eurasian National University, Kazakhstan: A Global Partnership

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Abstract - The countries of Central Asia have a legacy of environmental problems dating from the period of the Soviet Union. These countries are currently addressing the problems of the past and simultaneously planning to address future environmental challenges arising from economic development in the region. Recognizing the need for trained, environmental managers and engineers to address these problems, The Eurasia Foundation, with financing from the energy company AES and the US Agency for International Development, sponsored development of an interdisciplinary and multinational, Master of Science degree in Environmental Management and Engineering (MSEME) at the L.N. Gumilyov Eurasian National University (ENU) in Astana, Kazakhstan. The first cohort of students was admitted in fall of 2005 and will graduate the summer of 2007. This paper describes challenges of developing the MSEME program to meet principles set forth in the Bologna Declaration and USA graduate program standards. The MSEME program is an on-going case study of a global partnership of non-governmental organizations, aid agencies, business and universities working together for a much needed educational program in a rapidly developing part of the world.

Index Terms – Graduate degree, environmental management and engineering, Kazakhstan, USA, global partnership

INTRODUCTION

Most countries of Central Asia which were former republics of the Soviet Union have a legacy of environmental contamination that must be addressed to protect human health and the environment and to facilitate further economic

development. This contamination has been caused by historic practices associated with:

- Agriculture
- Mining
- Manufacturing
- Power generation
- Oil and gas production
- Population centers
- Weapons production and testing, and
- Space program facilities

In addition, the leaders of the countries of Central Asia must also plan for future environmental problems resulting from economic development necessary to improve the standard of living. Recognizing the need for trained, environmental managers and engineers to address these problems, The Eurasia Foundation (EF), with financing from the energy company AES and the US Agency for International Development (USAID), sponsored development of an interdisciplinary and multinational. Master of Science degree in Environmental Management and Engineering (MSEME) at the L.N. Gumilyov Eurasian National University (ENU) in Astana, Kazakhstan. From its inception, one of the principal objectives of the program was it be modeled after (or consistent with) graduate programs offered in Western Europe and North America.

The EF used an open competition to select a partner university to team with ENU. After narrowing the pool down to three institutions, the EF had each conduct a scoping/information-gathering trip to ENU in fall 2004. During that trip, the institutional team met with EF representatives and potential ENU program colleagues to discuss a wide variety of issues. Each of the institutions then submitted a proposal to EF for consideration. The team from The University of New Mexico (UNM) was selected by the

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EF after consultation with its funding partners and ENU representatives. Following the selection, the UNM team began working with the team leader at ENU, Dr. Serik Shaikhin and EF personnel to implement the plan for developing and offering the MSEME program by fall 2005. Throughout this project, the ENU and UNM teams have worked closely with EF personnel to create a rigorous and sustainable program.

CONTEXT AND APPROACH

The overall goal of the MSEME degree program is to provide training of young environmental managers and engineers to address environmental challenges facing Kazakhstan and Central Asia. The program is modeled after similar programs in the U.S. and Western Europe, which represents a new approach to graduate education in Kazakhstan. It was emphasized that this degree would be developed, owned, and administered by ENU; UNM's role is to provide assistance in this process. One important outcome from the program would be students who were environmentally literate as well as technically competent.

During the first phase (or Year 1) of this project/grant, activities focused on development of the multidisciplinary MSEME degree program through collaboration between ENU and UNM faculty members. The collaboration aimed to establish the requirements and curriculum for the new degree consistent with the Bologna Declaration for European Higher Education [1] and Master of Science programs in the USA. The degree was designed to take 24 months to complete and includes a research project/thesis. A further consideration, discussed later, was that the requirements and curriculum for the MSEME degree must be approved by the Kazakh Ministry of Education.

Integration of environmental and engineering concepts into a comprehensive curriculum is not a new idea. Weidenhofs [2] discussed the changing paradigms, or models, of ecology and engineering at the Colorado School of Mines in the USA. It was hoped that engineers could be educated to question the sustainability of production and consumption and whether or not there were better alternatives to current practices. Hyde and Karney [3] consider the concepts of environmental "caring" and "sensitivity" and how to integrate such into the engineering curriculum and its relationship to sustainability. A question they posit is what determines environmental competency and further should the onus of "caring" be solely on the engineer or on other professionals. Nair, et al. [4] discuss the concept of environmental literacy and propose that an environmentally literate person have an understanding of

- "interaction of the atmosphere, lithosphere, hydrosphere, biosphere, and anthroposphere;
- first and second laws of thermodynamics, practiced as energy balances;
- law of conservation of mass practiced as materials balances;
- ecological structures and biological evolution;
- interaction between population growth and resource consumption;

- industrial ecology, and life cycle analysis frameworks;
- risk, focusing on how quantitative risk is calculated, how it is communicated, and how it can be managed; and
- regulatory and ethical frameworks." (Nair et al. [4] p. 58)

Nair et al. [3] also believe that an environmentally literate student should have the ability to:

- "apply a systems approach and understand the limitations of system models;
- build from their initial understanding of an issue including using reliable sources of information and being able to discriminate among the data; and
- analyze, synthesize, and evaluate alternate solutions." (Nair et al. [4] p. 58)

Although Nair et al. [4] were talking about undergraduate curriculum; the same ideas apply to the graduate curriculum. Splitt [5] expands on environmental literacy and suggests how it and sustainable development can be further incorporated into accreditation standards at US engineering colleges. Velazquez et al. [6] discuss the engineer for the 21st century and sustainable development. They present the model used in the industrial engineering program at the Universidad de Sonora, Hermosillo, Mexico, which has an objective of a practical apprenticeship under and integral perspective of administrative, social, technical and ethical areas according to sustainable development concepts. Mulder [7] presents the historical, cultural and practical reasons for development of an engineering curriculum at the Delft University of Technology, Netherlands. Along with discussing the development of a special MSc graduation certificate, Mulder [7] states the lessons learnt as:

- An academic engineer should also be trained as an 'social engineer.'
- A cultural change in engineering education is needed.
- 'Hybrid' (multidisciplinary) lecturers are needed.
- To realize a cultural change both bottom up (faculty) and top down (university boards) approaches are needed.
- During changes in the educational systems within faculties all programs are 'under fire'. Therefore communication with all levels of decision making is important to keep what is built up.
- International cooperation and exchange is needed.

Recently, Jassim and Coskuner [8] proposed an educational scheme for environmental engineering education for the Gulf Co-operation Countries (GCC) of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. They found that environmental engineering subjects are most often taught in civil or chemical engineering programs in the GCC. The scheme they suggest follows the approach of Western universities. The concepts discussed in the literature cited above regarding environmental literacy, sustainable development, and how to craft an integrated curriculum were paramount in development of the MSEME program.

The new degree required ENU faculty with expertise in environmental management and engineering. Assistance has been given via three components. The first component was a series of summer short courses that were delivered to assist ENU faculty in development of their own graduate classes. The ENU team leader visited UNM in June 2005 to learn more about ENU's partner institution and faculty and to plan the summer short courses. In July 2005, the first set of courses was presented at ENU by UNM professors in the areas of:

- Surface and ground water hydrology
- Environmental chemistry and
- Environmental management

Following that set of courses, eight ENU faculty were brought to UNM to become acculturated to the US, New Mexico, and university life at UNM. During that trip in August 2005, professors from UNM and the New Mexico Institute of Mining and Technology presented short courses on:

- Organization and requirements of M.S. programs in the US
- Curriculum development
- Admission criteria
- Environmental chemistry
- Treatment processes
- Environmental management
- Introduction to environmental science
- Environmental economics
- Atmospheric physics, air pollution & air pollution control
- GIS applications in water resources, and
- Research collaboration

The visit to UNM also included meetings with campus administrators and trips to major environmental management facilities in the Albuquerque area and New Mexico. The objective of the short courses was not to completely cover all the topics, but to provide an overview so that the ENU professors could expand on the information. The UNM professors also provided their ENU counterparts with model course syllabi around which the ENU professors could develop their own courses.

In the second component, UNM faculty directly participated in teaching of courses and seminars at ENU. Prof. Greg Gleason is fluent in Russian and familiar with Central Asia environmental policies. He taught during fall 2005 and fall 2006 at ENU after being released from his courses at UNM. In addition to this long-term teaching, other UNM team members have travelled to ENU in 2005 and 2006 to present lectures and seminars in water resources engineering and environmental engineering. The third component consists of integrating the UNM and ENU teams to facilitate further collaboration. The first step was through the establishment of an Agreement on Cooperation in the Field of Science Education and Culture between UNM and ENU. This agreement was signed by the ENU Rector and the UNM President in September 2005. This agreement contains specific objectives to:

- Develop cooperation in different spheres of university life on the basis of equal rights and mutual benefit, including teachers, scientists, students, postgraduate students and other staff.
- Cooperate in joint research projects and exchange of scientists. Develop and support contacts between departments, laboratories and other research subdivisions.
- Cooperate in the field of developing distance education.
- Cooperate in the field of training for Master's degree and Ph.D. programs.
- Organize exchange of teaching staff to deliver lectures and conduct pedagogical work; exchange of academic literature and other information on curricula and syllabi.
- Exchange publications and other scientific materials, inform each other about scientific conferences and invite representatives of the contracting Party to participate in them.
- Organize exchange of students, postgraduate students and probationers providing them with necessary conditions for extending both theoretical and practical knowledge.
- Develop and support cooperation between the libraries of the contracting parties, including exchange of scientific and academic literature.

The second step was to appoint the ENU team leader as a Visiting Scholar at UNM under a letter of academic title. As such, he has access to UNM research resources via the Internet including libraries which contains numerous on-line articles. The third step, expanding on the second step, is the creation, as is permitted under the Agreement discussed above, of a Joint Faculty of ENU and UNM members with the following concepts:

- UNM and ENU will each recruit qualified faculty members from existing departments at their respective institutions to become members of the MSEME Joint Faculty.
- Each institution will prepare a list of those faculty members who wish to participate in the MSEME Joint Faculty including specializations and contact information.
- The lists of MSEME Joint Faculty will be updated every academic year, shared between the two institutions, and published on the MSEME Web site.
- UNM and ENU faculty members who participate in the MSEME Joint Faculty will be afforded the same privileges as visiting professors, researchers, or scholars are granted at their home institution. ENU faculty members who request it can receive a Letter of Academic Title (LAT) with UNM. The LAT allows ENU faculty the same access privileges as regular UNM faculty regarding an email account, the libraries, and other special events or services.
- The MSEME Joint Faculty will cooperate to seek support for the exchange of faculty and continued visits by faculty between the two institutions.

There are other structural reasons for the establishment of a Joint Faculty which will be discussed in a later section.

The outgrowth of the ENU and UNM short courses and meetings was to develop a broad curriculum to train future environmental managers and engineers. The UNM team suggested a curriculum with a mix of courses distributed as follows:

- Environmental and engineering science (~37%)
- Environmental economics and policy (~26%)
- Design of treatment processes (~37%)

This distribution of topics served as a starting point and was expected to change as further consideration was given to constraints and resources. To that end, the ENU team, with guidance from the UNM team created a curriculum which contains the following as requirements or electives:

- Mandated courses by the Kazakh Ministry of Education including history and philosophy of science, English, management, psychology, and higher school pedagogies
- Business Kazakh language
- Environmental microbiology and ecology – 3 courses
- Surface and ground water hydrology and engineering – 4 courses
- Physical, chemical, biological treatment of water, wastewater, and contaminated soils – 4 courses
- Atmospheric physics, air quality and air pollution control – 3 classes, and
- Environmental economics, environmental policies, and environmental management – 4 courses

Some specific courses are:

- Management of radioactive and hazardous wastes
- Environmental microbiology
- Microbiological remediation of soil and water
- Hydrology and hydrometrics
- Physics and chemistry of the atmosphere.
- Air pollution monitoring and control
- Remote sensing of the Earth
- Geographical information systems in water resources
- Environmental protection legislation and policy in the Republic of Kazakhstan
- Environmental economics and management of natural resources
- Chemistry and physics of the environment
- Chemical analysis of water and air
- Public administration in the environment protection
- Ecological assessment
- Water resources

The program also requires an industrial practice (internship) component and a Master of Science dissertation (thesis). The students have been working at a number of different businesses and agencies as they develop their thesis topics. These businesses and agencies include KazTransOil, Intergaz Central Asia, Republic of Kazakhstan (RK) Ministry of Environment Protection, Stepnogorsky mining-

chemistry industrial complex, AES Ekibastuz, an electric power station in Astana city, and RK property enterprise Astana Su-Arnasy. Subjects of theses from these linkages are:

- Effectiveness of the ecological management system implementation at Kazakhstan plants
- Engineering protection of air quality
- Ecological consequences of energy consumption growth in the Central Asia states
- Radiological situation in Kazakhstan
- Water resources management in the Republic of Kazakhstan
- Ecological monitoring of air, water, and soil, and
- GIS technology application in environment protection.

The MSEM program can be compared with other MSc degree programs with respect to courses and graduation requirements. One comparison can be made with the highly rated programs of the MSc in environmental sciences and the MSc in environmental assessment and management at the University of East Anglia, UK [9]. These MSc programs contain courses similar to those implemented in the MSEM program including hydrology, environmental economics, GIS, atmospheric physics, air pollution, risk management and waste management. Both those programs require a dissertation as well.

The first cohort of students was admitted to the MSEM program in fall 2005, and the second in fall 2006. The first cohort will graduate in summer 2007.

YEAR 2

Much of the planning, development, and training took place in Year 1 of the grant. During the second (current) year of the project, the emphasis shifted to program sustainability. The four components of sustainability are:

- Financial sustainability – This is described as the ability to obtain resources to pay for the program in the future. The Eurasia Foundation's Request for Proposals specifically identified this measure of sustainability, however, it is important to recognize that there are other ways of measuring sustainability
- Academic sustainability – This aspect of sustainability considers the ability to attract high quality students and assure that they graduate with a high level of knowledge, and that they are prepared to meet the technical and societal challenges of their chosen profession
- Intellectual sustainability – Development of high quality research program that is able to produce research of value to Kazakhstan and attract funds for new research projects
- Technical sustainability – Produce well educated students who are able to move into society, obtain good jobs and help address environmental challenges of Kazakhstan and Central Asia. At the same time, technology taught and developed by the

university must address the environmental challenges in Kazakhstan.

A central element is the research component because research projects provide financial support for the program, increase its visibility, and enhance the technical competence of the faculty and students. UNM researchers collaborate with ENU faculty to identify research projects and sources of support for the program. Potential sources of support include the Kazakhstan and international governments, industry and municipalities in Kazakhstan, and non-governmental organizations. Another aspect of sustainability is recognition of the program at ENU as a free-standing faculty. This aspect will be discussed in a later section.

During the second year, funding has been provided by the EF to acquire instrumentation/equipment for ENU. The equipment funds were split between ENU for direct purposes and UNM. The equipment will permit analyses of water, soil, and air samples for inorganic constituents (metals and non-metals), selected organic contaminants, and physical properties of water and air. The UNM team is pursuing purchases of this equipment because UNM receives more favorable pricing. Title to the equipment will be transferred to ENU as part of the grant. The second year of the grant ends in September 2007. Before the end of Year 2, an outcomes assessment will be conducted to determine the success of the program to that date. The project is expected to continue for one additional year into 2008.

CHALLENGES

Developing any new program in a university is a daunting process whether it is in the USA, the EU or Central Asia. The first challenge faced was the language difference between the two teams with the ENU team conversant in Russian with only a few English-as-a-second-language speakers, and UNM with English speakers and only one member fluent in Russian. This gap was bridged, somewhat, by translators provided by ENU and Professor GG from UNM. A second challenge was the admission criteria for the program. Two criteria suggested by the UNM team were that students admitted to the program should be conversant in English and come from an appropriate science, engineering or similar background. Being conversant in English was deemed important because the great majority of environmental technical literature is in English. All of the students applying to the first cohort were screened with an English proficiency test, and ten students were accepted. However, the backgrounds of these students were extremely variable and included students with very little training in environmental science, engineering, or management. The second cohort was technically more qualified, but the English screening test was not employed, which resulted in only a few of the 11 students admitted being conversant. A third challenge is lack of reliable high-speed Internet access for the ENU team members and the MSEME students. This is a critical university infrastructure component which is taken for granted in the USA and the EU but is not widely available in Central Asia. The lack of Internet access makes it more difficult for effective communication among the team

members and the students. A fourth challenge is finding a home for the program. At present, the MSEME program is under the Geography and Ecology Chair of the Natural Sciences faculty, but the program has a number of engineers teaching courses as well as biologists from Ecology. This creates a situation where the loyalties of the program participants are divided between the home faculty and the MSEME program. The ENU Rector is addressing this challenge by taking necessary steps to create a Faculty of Environmental Management and Engineering. One step in that direction is creation of the Joint Faculty between ENU and UNM. The existence of the Joint Faculty will assist the Rector when he makes his case to the Ministry of Education which oversees and approves of all new programs/faculties in Kazakhstan. At present, the MSEME program is not an approved, stand-alone degree by the Ministry, but is a subset of the Ecology program. This creates a fifth challenge, the ability to attract new, qualified students to the MSEME program. At the other end of the program is a sixth challenge, placement of the students upon graduation. Some of the students will go into agencies or other areas of employment. However, others wish to go on for further education at the Ph.D. level. Those students wishing to pursue a Ph.D. degree will need to investigate environmental programs which are open to the broad educational background they have received while earning the MSEME. One option which has been discussed is creation of a doctoral program in environmental management and engineering at ENU. However, the project team believes that before a Ph.D. program is implemented, the MSEME must first establish a track record of success. Associated with this fifth challenge is a sixth challenge regarding development of a viable research program in this multidisciplinary field. A recognized research program is needed to attract both M.S. and Ph.D. students. ENU is a new institution and as such does not have a long history of research. Even so, competitive, quality research is being conducted in some areas related to the program. Therefore, the sixth challenge is to assist ENU so that the MSEME, and perhaps a future Ph.D. degree, can realize the opportunities for professional recognition and financial development that come with a successful research program.

As the MSEME program matures and becomes more visible, it will find its own home at ENU. The research program will grow through careful attention. When those two elements are in place, it is expected that the program will be sustained.

CONCLUSIONS

Developing new environmental graduate programs is a challenging task. Doing so when the partners are half a world apart with language, academic, and cultural differences makes it even more interesting. However, through a concerted effort on the parts of all the participants – universities, agencies, business and non-profit organizations – a program has been created and delivered. The biggest challenge now is to sustain the success.

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