

Experiences in Distance Education for a Graduate Engineering Program

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Abstract

The U. S. Army Corps of Engineers principle R&D facility, the Engineer Research and Development Center (ERDC), consists of seven laboratories that are located at four different geographic locations. The headquarters is located in Vicksburg, Mississippi, at the ERDC site known as the Waterways Experiment Station (WES). It is over 150 miles from Vicksburg to the nearest university offering graduate-level engineering and science curricula. At one time, this limited educational opportunities for the engineers and scientists working in the area. Now, the 1,100 engineers and scientists in the Vicksburg area have access to a variety of educational resources from three well-known and respected universities that offer programs on-site through the Graduate Institute. Since its earliest days in the 1960's when it was known as the Vicksburg Graduate Program, this distance-learning center has progressed from a small core group of students, dedicated instructors and administrators to a consortium of three major universities offering a wide variety of degree options at the Master of Science level. The Graduate Institute was established in 1986 and is an association of universities and the WES through which academic credit and graduate degrees can be earned from the member universities: Louisiana State, Mississippi State, and Texas A&M. This paper presents the historical background on the institute, the programs, the importance of cooperative efforts to provide graduate engineering and science education to an off-campus site, and how these educational opportunities assist us in recruiting, retaining, and maintaining a high-quality R&D workforce.

History of ERDC/WES

In the fall of 1998 the four Corps of Engineer Research Facilities were reorganized into one organization, the US Army Engineer Research and Development Center (ERDC). The ERDC consists of seven unique laboratories at four geographic locations: (1) Coastal and Hydraulics Laboratory (CHL); (2) Environmental Laboratory (EL); (3) Geotechnical and Structures Laboratory (GSL); (4) Information Technology Laboratory (ITL) all Vicksburg, MS; (5) Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NH; (6) Construction Engineering Research Laboratory (CERL), Champaign, IL; and (7) Topographic Engineering Center (TEC), Alexandria, VA.

The total ERDC staff numbers more than 2,000 engineers, scientists, and support personnel. The annual ERDC research program is more than \$690 million. The ERDC has \$1.2 billion in facilities and equipment, including some of the most unique and modern research facilities in the world. The ERDC hosts one of four Department of Defense High Performance Computing (HPC) Centers; the ERDC HPC Center has four supercomputers with a capability of 1.7 trillion calculations a second. Other facilities include the world's most powerful centrifuge, a permafrost tunnel, physical models of inland and coastal

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areas, shake tables, vehicle simulators, chemistry laboratories, frost and ice engineering facilities, an 1800-foot coastal research pier, and a wide variety of specialized laboratory and computer areas to support diverse ERDC research missions.

The ERDC organization - its facilities and equipment, its people and their expertise, its ability to address a variety of diverse problems - provides an unmatched R&D capability. ERDC provides solutions to the most complex problems facing our Nation today, and tomorrow.

Now let us look specifically at the ERDC Vicksburg site, known as the Waterways Experiment Station (WES). On June 18, 1929, following the tragic Mississippi River Flood of 1927, the US Army's Chief of Engineers directed the President of the Mississippi River Commission (MRC) to establish a hydraulics laboratory in the alluvial valley of the Mississippi River for the purpose of developing cost effective flood control technologies for the Lower Mississippi River Valley. The Chief of Engineers, in approving the project, stated that an experimental and research force, with the necessary personnel and equipment, should be set up at once and expanded according to need. The Director of the laboratory should operate directly under the President of the MRC. After looking over possible sites around Vicksburg, an ad hoc committee submitted a report to the President of the MRC on December 9, 1929, recommending construction of the laboratory at a location on Durden Creek, 4 miles south of town. Purchase of the land for the WES was approved by the Secretary of War on February 14, 1930.

The role of WES as the first federal hydraulics research facility was to help the MRC develop and implement a flood control plan for the Lower Mississippi River Valley. From modest beginnings (the first river model was dug in natural soil using a grapefruit knife), WES has grown steadily to become the largest and most sophisticated research facility of its kind in the world.

Today there are over 1,200 employees at the WES site, including several full-time members of the US Armed Forces. Over 650 of these employees are engineers and scientists who are widely known and respected for their work in such diverse areas as hydraulics, oceanography, chemistry, electronics, physics, mathematics, soils, seismology, limnology, forestry, microbiology - virtually every major scientific and engineering discipline (Cotton, 1979). WES research is carried out in four separate, but closely interrelated laboratories: Coastal and Hydraulics Laboratory, Geotechnical and Structures Laboratory, Environmental Laboratory, and Information Technology Laboratory.

With this wide array of research efforts at advanced levels, there has always been a need for formal postgraduate instruction in engineering and science at WES. For many years this was done through informal on the job training or more formal and expensive long-term-training assignments.

Nature and History of the WES Graduate Program

Early years 1956-1962

In 1956 a dialog was initiated between the Command Staff at WES and the MSU Graduate School and the College of Engineering. As a result of these early discussions, the clearance to proceed with establishing a Graduate Program in Engineering at WES was set in place in 1958. This early program addressed many of the concerns that still come to the forefront of our program today: center name, administration, instructional personnel, off-campus and on-campus study, fees, salaries, registration, facilities, and resources.

1963-1986

Interestingly enough, even with the “proper clearances of the university and Board of Trustees” mentioned in the memos of 1958, it took almost five years to implement a preliminary program. The same issues kept showing up from December 1958 to March 1963. In March of 1965, the initial offerings were listed for initiation in summer of 1965. The first courses listed were mathematics refresher courses to assist with academic preparedness. Courses in Civil Engineering, Engineering Mechanics, and Mathematics began in the fall of 1965.

From 1965 through the mid 1980’s WES underwent an unprecedented period of growth, expansion, and change. The Cold War was raging, Vietnam came and went, and the military build up of the Regan years contributed to this organizational evolution. Along with these changes in the organization, major needs for advanced education at the graduate level saw larger enrollments in the on-site MSU-WES program. The use of long-term-training for PhD level education was also on the rise. A total of 65 graduates of the program were listed over this 20-year period. Over 20 of these individuals went on to pursue and complete doctoral degrees in their respective fields.

1986-2000

During the later half of 1980’s major changes continued at WES. Colonel Allen Grum, a visionary who served as the WES Director from 1985 to 1986, had a history of involvement with higher education from his tenure at the United States Military Academy at West Point. Dr. Robert Whalin was the Technical Director of WES during this time. Both individuals strongly encouraged and supported higher education at the graduate level for our engineers and scientists. This support was evidenced by establishing the WES Graduate Institute in July of 1986. The Graduate Institute (Figure 1) is a consortium of WES and three major universities offering a wide variety of degree options at the Masters level. Academic credit and graduate degrees are earned from the member universities: Louisiana State, Mississippi State, and Texas A&M. With this increase in degree option, the number of students and graduates began to increase steadily.

Issues such as transfer credit between member universities, residency requirements, minimum requirements for acceptance into programs, non-competing program requirements, adjunct faculty versus full-time faculty, and many others were repeatedly hashed out to iron the wrinkles from this canvas.



Figure 1. A consortium of three Universities and the WES

Graduate degree options for each Member University are shown in Table 1.

| Louisiana State University | Mississippi State University | Texas A&M University |
|----------------------------|--|----------------------|
| | | |
| Engineering Sciences | Civil Engineering Environmental Geotechnical Hydraulics Structural | Ocean Engineering |
| Environmental Sciences | | Oceanography |
| Experimental Sciences | | |
| | | |
| | Computational Engineering | |
| | Engineering Management | |
| | Electrical and Computer Engineering | |
| | Industrial Engineering | |
| | Computer Science | |
| | Mathematics and Statistics | |
| | Business | |

Table 1

2000 and beyond

The ERDC and WES currently focuses on five primary areas in support of Army transformation and the Corps of Engineers civil works mission: Military Engineering, Battlespace Environment, Facilities and Infrastructure, Environmental Quality, and Water Resources. As missions evolve to support our role as the nation's engineering organization, the Graduate Institute will continue to play a major role in meeting the higher education needs of the R&D workforce at WES.

Participation Factors

As stated earlier, the Graduate Institute is an association of universities and the WES through which academic credit and graduate degrees can be earned from Member Universities that offer programs at WES. The Institute functions through joint agreement between WES and Member Universities (Louisiana State, Mississippi State, and Texas A&M). Academic oversight is given by the Graduate Institute Administrative Board, a group composed of a representative from ERDC/WES and each Member university.

Agency

As a sponsoring agency for an on-site graduate program, the WES continues to realize a number of benefits from the Graduate Institute and its programs:

The various WES R&D labs are able to attract recruit and retain top quality new gradates at the bachelors level in highly competitive engineering and scientific disciplines.

As recently mentioned in a Town Hall meeting:

“Dear GSL,

I'm sure you've noticed ... 29 new full-time employees in GSL in the past 15 months, 11 in the past 3 months alone! ...

Technology transfer is provided a unique opportunity through an on-site program using several mechanisms including, interaction with other professionals, instructors to student interaction, peer to peer interaction, dissemination of R&D findings through incorporation in academic content, effective mixtures of fundamental and applied courses, and practical instruction and examples for R&D and design professionals

Employees are afforded several important features including: increased technical competence, fulfillment of license requirements, and incorporation of graduate study into individual development programs.

University

The supportive relationships required for the operation of this type of off campus program are generally established in recognition of the importance of science and technology education to the future political, economic and technological well being of the nation as well as the importance of institutions of higher learning to the business, industrial, and governmental institutions in the region.

The universities involved in the program realize several benefits including: exposure of university capabilities to Corps engineering and scientific staff, interaction of faculty with other scientists and researchers, cooperative research, use of research facilities, and co-authored publications. On-campus traditional students also see benefits in the form of: research support, employment opportunities, and contact with prospective employers.

A strong adjunct faculty and a willingly on-board and involved campus faculty are critical to an off-campus program. A few characteristics of the WES adjunct faculty are:

Over 65 ERDC PhD engineers and scientists hold adjunct faculty appointments at MSU, LSU, or TAMU; 20 of these have offered classes on a regular basis at WES during the past 10 years; decades of practical experience in Civil Engineering design, construction, analysis and R&D; highly motivated and very active professionally; and easily accessible and student oriented

Student Needs, Benefits and Trends

One of the key issues in the success of any off-campus program is achieving a proper mix of the traditional campus oriented environment and the needs of the non-traditional student. One method of achieving this is to be certain the students are exposed to both environments regularly through mixes of adjunct and full faculty taught courses, regular visits either on-campus or off-campus with full time faculty and committees, and offering sufficient numbers of courses to permit completion of a well-rounded degree program in a timely manner.

The typical on-campus minimum enrollment requirement is somewhat higher than practical for most off-campus programs. The sponsoring agency can offset this with supplemental buy-in in the form of fiscal support, staffing support, facility loans, and other methods for reducing the overall cost of the operation of a graduate campus.

The Civil Engineering Master of Science program from MSU has been the most successful of all the WES Graduate Institute programs. This is due in large part to the mission and staffing of the WES in the Civil Engineering area. The establishment of a formal program in 1986 also presented some major improvements in the success rate of the program that can be measure in terms of graduates. From 1965 until 1986, there were a total of 65 graduates from the MSU Vicksburg Graduate Program in Engineering. From 1986 until the present, there have been more than 180 graduates from the programs of the Graduate Institute from the three universities combined. More than 30 graduates have gone on to complete PhD degree programs from major universities all over the U.S. and abroad (Figure 2). This would indicate that a more formal, diverse, and flexible program with dedicated staff generates greater interests and student participation.

WES Graduate Institute student benefits include; greater synergy among students, minimal commuting distance, minimal loss time from duty stations, cost efficient: (\$17 per hour of instruction vs. \$60 per hour for short courses), total degree cost (~\$8500 tuition and books), serves advanced educational needs of employees, serves advanced educational needs of the organization and employers while meeting continuing education requirements for professional engineer registration.

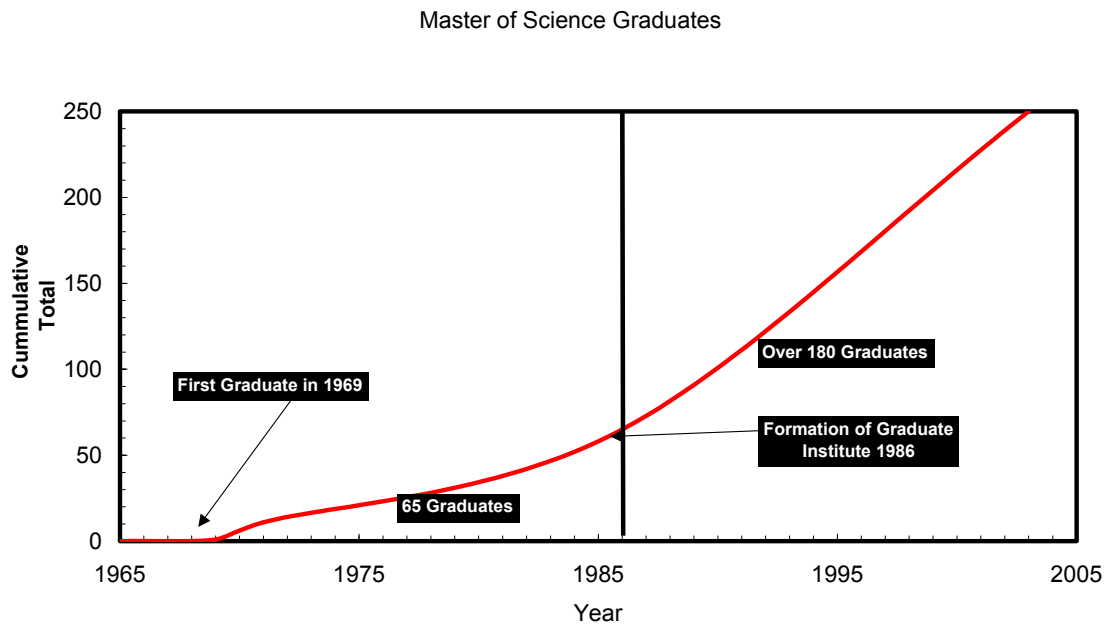


Figure 2. Cumulative Graduates of the Program by Year

True Measures of Success

The true measure of success in a program like the WES Graduate Institute can best be expressed in the words of the Graduates and the actual accomplishment of completing a degree. A few of those comments are listed below:

“When I finished my BS in 1980, I had several job offers, including the high-paying oil companies. I accepted my lowest offer at the time, the Corps in Vicksburg, for one reason: the Graduate Institute (GI). I planned to get my MS at the GI and then leave the government. The education prepared me for long-term training for my PhD, and I'm still with the Corps. The GI was a very good deal in that it allowed me to further my education while working. Otherwise, I never would have gone beyond a BS. Now, I get the satisfaction of teaching at the GI and helping the young folks grow in their profession.”

“I came to the Waterways Experiment Station seventeen years ago with a Bachelors Degree in Petroleum Engineering and a few years of experience in the oil industry, yet my new job title was "Civil Engineer." I desperately needed to build my new found identity as a civil engineer quickly, and the Graduate Institute provided me that opportunity. I began taking civil engineering graduate classes during my first year at WES, and without having my coworkers as fellow students and sometimes as the class faculty, I'm not sure I would have had the chance for success that I enjoyed. I now have masters and doctoral degrees in civil engineering, and am a proud member of the American Society of Civil Engineers. The Graduate Institute was a major part of my early training experience, and remains today as a significant part of my identity as a Research Civil Engineer.”

“I certainly would not have had the opportunity to get my Masters degree without the ability to take courses here at the station. MSU would not accept me into the Masters program because of my undergraduate degree; however, with a change of leadership at MSU and the over 30 hours of coursework I had taken - I was able to get a Masters by attending a full summer semester up at Starkville. Of course without the Masters, I would not have gotten my PhD. I was able to transfer 6 hours of course work that I had taken here through MSU towards my PhD requirements.”

“The Graduate Program at WES was one of the Major Factors in my ability to succeed in my Chosen Career Field.”

“The Graduate Institute is one of the primary attractions for most young engineers and scientists coming to work at the Engineer Research and Development Center at Vicksburg. It's an excellent recruiting tool for attracting the best and brightest to work at ERDC. In my case, it wasn't the reason I came to Vicksburg, but it's certainly one of the reasons I stayed. The ability to conveniently take graduate courses and obtain a Master's degree from Mississippi State University, while working fulltime, was an opportunity too good to pass up. Not only did it give me a sense of accomplishment, but it prepared me to work in a research environment much more effectively, and it also positioned me for long-term training at the University of Texas, where I obtained my PhD.”

The stories that we hear are similar to these most of the time. A program with flexibility and quality creates unique opportunities to have our best and brightest complete advanced degrees and retain their expertise as a corporate asset.

What the Future Holds!

The future of the Graduate Institute and graduate education at the WES is very bright. Over 30 new employees have been hired in the last two years, thereby generating a new student body to take advantage of opportunities for advanced degrees. The quality of distance education has benefited both the Graduate Institute and the Main Campus' of the Member universities through offering of courses originating from either end. Continued strengthening of University/WES relationships and seamless operation is another aspect to a truly world class program.

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Donald M. Smith

Donald M. Smith is a native of Soso, Mississippi. He earned his BS (1983) and MS (1990), both in Civil Engineering, from Mississippi State University and his Ph.D. (2000) in Civil Engineering from Louisiana State University. Dr. Donald M. Smith is the Associate Director of the WES Graduate Institute and a research civil engineer in the Geotechnical and Structures Laboratory (GSL), U. S. Army Engineer Research and Development Center (ERDC), where he conducts research and development in the field of pavements and materials engineering focused on modeling and analysis of military transportation infrastructure for both fixed facilities and contingency operations. His work at WES has concentrated on mechanical behavior of construction materials and the development of mathematical models for numerical analysis of geotechnical and pavements problems. Dr. Smith has built a highly effective interdisciplinary Pavements Modeling and Analysis Team whose diverse talents and backgrounds have been effectively harnessed to solve some complex problems in modeling of pavements and characterizing the response of pavement materials under the extreme conditions of military force projection. Dr. Smith has established himself as an expert in pavement material property characterization and high performance analytical modeling of pavement systems, where he has broken new ground in the use of advanced constitutive models for soils and pavement materials. Dr. Smith is an adjunct faculty member in the Department of Civil Engineering at Mississippi State University, where teaches graduate level engineering courses at the ERDC WES Graduate Institute. He is currently serving as committee member/advisor on six Master's Degree committees from MSU and one PhD committee affiliation from Purdue University. He has authored or co-authored seven referred publications, 10 papers in conference proceedings, and 25 technical reports in this field. Dr. Smith has worked at ERDC since 1983.

C. H. Pennington

Dr. Jim Pennington is the Director of the Graduate Institute, U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS, since 1986. The Graduate Institute is an association of universities and the ERDC through which academic credit and graduate degrees can be earned from Member Universities that offer programs at the ERDC.

He also is the Program Manager of the ERDC Personnel Demonstration Project since 1994. The Personnel Demonstration Project is sponsored by the Department of Defense and was implemented to allow the ERDC to compete more effectively for high-quality personnel, to motivate and retain staff through pay for performance, and to have a more responsive personnel system.

Prior to becoming the Institute Director, Dr. Pennington served as a research biologist in the Environmental Laboratory where he conducted ecological studies on many of the major river systems in the U.S. He has also served on the faculty at Texas A&M University and Southeastern Louisiana University. He is an adjunct faculty at the University of Southern Mississippi, Jackson State University, and Southeastern Louisiana University.