

A Double Pipeline of US Domestic Undergraduates for the University of Cincinnati Nuclear and Radiological Engineering Graduate Program

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1. Introduction

Attracting a greater number of US domestic students into graduate programs and enhancing the ethnic diversity of the graduate student pool are goals shared by virtually all engineering graduate programs. For a nuclear engineering program, in particular, achieving or striving toward these goals can go beyond simply improving the visibility of a particular program. In fact, it can reshape and improve the attractiveness of the program to future graduate student recruits, it certainly improves the relationship with potential employers, and can ultimately materialize into increased federal funding from such sources as the US Department of Energy (DOE) and the National Science Foundation (NSF), organizations who share and support the above-noted goals.

Accordingly, the University of Cincinnati's (UC) Department of Mechanical, Nuclear, and Industrial Engineering (MINE), specifically the Nuclear and Radiological Engineering Program, currently operates two successful programs that have been designed to explicitly "pipeline" talented US domestic undergraduates from various fields of science and engineering and from diverse ethnic backgrounds into its graduate program.

One such program, initiated in 2003, is a 5-year dual degree (BS Mechanical Engineering + MS Nuclear Engineering) which targets students typically seeking to enter a mechanical engineering undergraduate track. This program is known internally as the MNE-ACCEND program (Mechanical and Nuclear Engineering - ACCelerated Engineering Degree) [1-2]. A second initiative, now entering its second 3-year term and partially sponsored by the US Department of Energy (DOE), is a "summer bridge" program that targets undergraduates from Tuskegee University (TU) at the sophomore and junior levels, and ultimately entices these underrepresented minority students into UC's graduate program in nuclear and radiological engineering [3].

The purpose of this article is to share some of the details in these two programs, to provide a status report on their ongoing progress, and to highlight a few of the mechanisms that have led to the success of these graduate school "feeder" programs. Also, this article highlights some details within these programs that directly address one or more of the specific areas of interest to this special session and its audience, such as:

- Use of distance learning in nuclear engineering,
- Utilizing laboratory experiences to facilitate student learning, and
- University nuclear engineering program interactions with industry and national laboratories.

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2. Brief Description of the MNE-ACCEND Program

As previously noted, “MNE-ACCEND” is an acronym for the University of Cincinnati (UC) Mechanical and Nuclear Engineering ACCelerated ENgineering Degree Program. MNE-ACCEND is an integrated 5-year academic program leading to a BS degree in mechanical engineering and an MS degree in nuclear engineering. The combination of two degrees in a compact time frame, coupled with the experience gained through cooperative education has been a strong selling point for the MNE-ACCEND program. The MNE-ACCEND Program has the following goals:

- To create a means by which a select group of highly motivated, well-qualified students can earn a BS-ME degree and an MS-NE in five calendar years.
- To increase the versatility, visibility and attractiveness of UC’s ME program at local, regional, and national levels, while also increasing the number of students entering the ME Program by about 10 to 15 additional new students yearly.
- To develop a pipeline of talented and motivated students that feeds into the UC Nuclear and Radiological Engineering (UCNRE) Graduate Program.
- To position the UCNRE Graduate Program into a leadership position in addressing the expected demand for ~90,000+ skilled new workers in the nuclear industry projected in the next decade by the Nuclear Energy Institute.

MNE-ACCEND students have five, one quarter Co-op sections – one less than in the standard UC engineering curriculum. Limiting the number of Co-op quarters to five, allows one additional on-campus academic quarter before MNE-ACCEND students receive their BSME degree. While on co-op, MNE-ACCEND students take one class each quarter using distance-learning techniques with support before and after the co-op quarter from UCNRE Program Faculty.

Except for one class, MNE-ACCEND students take all of their ME courses in the sequence specified in the standard undergraduate ME curriculum and receive their BSME degrees with ME classmates in June of their senior year. At that time they will have completed almost all of the class work required for the MSNE. MNE-ACCEND students are able to complete all of the MSNE degree requirements at the end of their post-BSME summer quarter – five calendar years after entering UC -- by:

- Enrolling into one additional academic quarter while an undergraduate.
- Taking five **distance-learning** courses while on co-op sections.
- Registering for the summer quarter following their BSME degree

As all students at the University of Cincinnati, MNE-ACCEND students are required to participate in a mandatory co-operative educational program. At least two of the five Co-op professional practice assignments are expected to take place at National Laboratories, Nuclear Utilities, and/or at various nuclear industry vendors with a mechanical and nuclear engineering orientation. The standard number of MNE-ACCEND co-op rotations is five, each of a duration equivalent to one academic quarter. In addition, students in the program have the opportunity to pursue an optional internship assignment during their first summer at UC.

3. The Tuskegee University and University of Cincinnati “Educational Bridge” Program

Via collaboration between the UC Radiological Engineering (UCNRE) Program and Tuskegee University (TU), an effective “educational bridge” between TU and the UCNRE has been developed. The collaboration began in the fall of 2001 with support from the DOE Nuclear Engineering University Partnership (NEUP) Program. It should be noted that a majority of the DOE award is used for TU student support and travel. Additionally, this project has recently entered its second 3-year term of DOE support that should extend from 2005 until 2008.

The objective of this program is to alleviate the current shortage of minority engineers and professionals in the nuclear industry by building an educational bridge between TU and the UCNRE Graduate Program. Tuskegee students crossing the bridge are able to earn a UC Master’s Degree in either Nuclear Engineering or Health Physics, and then are in a position to enter the nuclear industry as professionals or to pursue further graduate work.

Beginning in the fall of 2001, TU undergraduates in engineering and the physical sciences were recruited for the TU-UC Educational Bridge Program. Every year, for the past three years, four to five TU undergraduates have been selected from the applicant pool and admitted to the TU-UC Bridge Program and designated as “Bridge Scholars.”

The program proceeds along the following seven steps:

1. TU undergraduates are recruited to apply for the program in the fall semester.
2. Bridge Scholars are selected from the applicant pool.
3. Scholars participate in ten weeks of summer activities at TU and UC.
4. Scholars continue research activities in the following fall and spring semesters at TU.
5. In the spring semester, graduating students are encouraged to apply for the UCNRE Graduate Program.
6. With support from the participating faculty, Scholars obtain summer internships in the nuclear industry, either at a national laboratory or a nuclear power utility.
7. Scholars who have not graduated continue in the program and repeat the process from step 4.

The 10-week session during the Bridge Scholars’ sophomore or junior year summer is the key element of the program. The summer session consists of introductory lectures on nuclear engineering and health physics, integrated with laboratory experiences and field trips to nuclear facilities. The summer session provides the Scholars with a solid grounding in the basic principles of applied nuclear engineering and builds a working relationship with the TU & UCNRE faculty.

The summer session is divided into two parts. The Bridge Scholars spend the first four weeks at TU and the subsequent six weeks at UC. During their stay at TU, the Bridge Scholars attend classes every morning covering the fundamental characteristics of nuclear radiation. The Bridge Scholars are also introduced to the methods of research in a teamwork setting. The scholars are grouped into two teams. Each team picks a research topic relevant to nuclear science and engineering. The teams use library and web-based Internet resources to gather information about their topic, then submit a literature survey report and make an oral presentation to their peers.

The Scholars spend the second six weeks of the summer session at UC where their room and board are provided and they have full access to the UC libraries, recreational facilities, computer labs and other UCNRE Program resources. In other words, providing a very real “college campus experience.” At UC, the Scholars continue their in-class sessions which are reinforced by laboratory experiences utilizing the UCNRE radiation measurements laboratory. A week at UC typically includes 7 two-hour lecture sessions and 2 three-hour laboratory sessions. The lecture topics present material on the interaction of radiation with matter, radiation detection, radiation shielding, reactor theory and engineering, physical principles of nuclear reactors, nuclear power plant systems, biological effects of radiation and radiological engineering.

To provide the Scholars with a comprehensive perspective on the scope of nuclear engineering, four field trips are made during summer session. Sites typically visited include a nuclear power plant training center, ORNL, the Cook NPP, the Ohio State University Research Reactor, a commercial irradiation facility, NIST, the NRC and NEI. The UC Professional Development Office and the UCNRE faculty also work with the Scholars to develop a professional resume and effective interviewing skills. Finally, when the Scholars return to TU in the Fall Semester, they are required to expand their research on the same or related topics they investigated during the summer and explore these topics in greater depth.

4. Recruitment and Outcomes: A Success “In Progress”

With regard to the MNE-ACCEND program, the first class recruited in 2003 attracted approximately three times the number of total applicants relative to established recruitment targets. Based on current and projected resources, the program’s goal is to ultimately support a steady-state stream of roughly 8 to 12 graduates per year. Furthermore, it has become evident that the nature of a dual-degree with an undergraduate and graduate component inherently tends to attract some of the best qualified entering engineering students. In fact, after two complete academic quarters, the majority of students in the MNE-ACCEND have shown to be high performers with GPA’s exceeding 3.3/4.0 early in their academic careers. Aside from preparing these students to reach the appropriate academic standing before they enter the graduate phase of the program, their good grades have already translated into additional scholarship awards at local and national levels (i.e., ANS, NANT).

The second class recruited in the fall of 2004 has attracted a similar number of well-qualified students, and the current number of students in good standing in the program stands at 16; whereby 8 are in the graduating class of 2008, while an additional 8 have entered the graduating class of 2009. It should be noted that a total of 4 students have left the program due to school/program transfers or because of low grades. Also, in a relatively short time, the MNE-ACCEND program has begun to reach some national attention and, in fact, 2 of the 8 students in the class of 2009 are recruits from out-of-state who specifically sought this dual-degree combination (Missouri and New York). Recruiting for the Class of 2010 is well underway, and in fact, about 10 qualified applicants have been accepted six months ahead of the start of the school term.

Similarly, the TU-UC educational bridge program has been highly successful. Since its inception, it has trained thirteen TU students in the field of nuclear engineering. Most recently, the fruits of this project have resulted in the entry of three TU BS graduates into the UCNRE Graduate Program during the fall quarter of 2004. Furthermore, commitments have been obtained from four DOE national

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laboratories (ANL, ORNL, LANL, and INEEL) to support the Bridge Program. National Laboratory support takes various forms including Bridge Scholar summer internships that provide extensive opportunities for interaction with DOE laboratory staff. Two laboratories host Lab visits that provide another vehicle for interaction between Lab staff and the Scholars. The result of the foregoing initiatives combined with the dedication and commitment of the involved UC, TU and DOE Laboratory personnel, has been the construction of a strong educational bridge between the two universities and the participating DOE facilities. The program is now starting to produce a steady stream of well-equipped, optimistic, and highly motivated graduate students for the UCNRE Graduate Program who will soon be in a position to become professionals in the nuclear industry.

5. References

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