

Preparing Versatile Engineers for the Nuclear Industry

Audeen W. Fentiman
The Ohio State University

Introduction

During its meteoric rise in the 1960s and 1970s, the nuclear industry hired thousands of engineers. As the industry matured in subsequent years, the number of employees leveled off. Now, many of those engineers hired in the 1960s and '70s are approaching retirement. Since a substantial fraction of the nuclear industry's workforce is about to retire, the demand for employees with an understanding of nuclear science and technology is about to grow. Nuclear power plants are operating more efficiently than ever, making them an important asset to utilities and increasing the likelihood that 20-year license extensions will be sought for most of the plants. With concerns about greenhouse gases growing, there is a renewed interest in nuclear power. A new generation of nuclear power plants is being designed, and the current administration in Washington supports construction of a new nuclear power plant by 2010. It appears that the number of nuclear power plants will remain stable or grow over the next few decades. In addition, other uses of radioactive materials, such as medical treatments and diagnoses, non-destructive testing, food irradiation, and research in many fields, continue to grow.

The nuclear industry requires a workforce with a wide range of capabilities. Certainly, it needs nuclear engineers. But it also needs mechanical, chemical, electrical, and other engineers with an understanding of nuclear science and technology. In addition, it needs health physicists or environmental scientists and engineers, chemists, geologists, and health professionals who have mastered the basics of radiation science.

The Ohio State University has a graduate program in Nuclear Engineering which offers M.S. and Ph.D. degrees and prepares its students for employment in utilities, research laboratories, nuclear medicine, regulatory agencies, and so on. However, OSU's Nuclear Engineering Program also uses four other established programs to provide students from other disciplines with knowledge of nuclear science and technology that will prepare them for careers in the nuclear industry. Those programs are:

- 1) Undergraduate minor in nuclear engineering
- 2) Graduate minor in radiation safety
- 3) BS/MS program
- 4) Dual masters degree program.

The undergraduate and graduate minor were developed by the Nuclear Engineering Program and guided through a long review process culminating with approval by a university-wide academic

council. The BS/MS and Dual masters programs are established programs managed by OSU's Graduate School but infrequently used. The Nuclear Engineering Program has been a leader in utilization of these programs to provide our students with skills they need for employment in the nuclear industry. This paper describes the four programs.

Undergraduate Minor in Nuclear Engineering

The Undergraduate Minor in Nuclear Engineering at Ohio State requires a student to take seven courses in Nuclear Engineering. Each student in the minor must take four core courses and 3 courses from a list of options. The courses are:

Core

- NE 505 Introduction to Nuclear Science and Engineering (3 credit hours)
- NE 606 Radiological Safety (3 credit hours)
- NE 708 Reactor Theory (4 credit hours)
- NE 736 Nuclear Power Plants (3 credit hours)

Options (select 3)

- NE 716 Probabilistic Reliability Safety Analysis (3 credit hours)
- NE 720 Reactor Dynamics and Control (3 credit hours)
- NE 735 Power Plant Operations I (3 credit hours)
- NE 742 Nuclear Radiations and Their Measurement (3 credit hours)
- NE 743 Nuclear Radiations and Their Shielding (3 credit hours)
- NE 771 Radioactive Waste Management (3 credit hours) .

Ten credit hours of these Nuclear Engineering courses may be counted as technical electives in the student's major with the approval of his or her major advisor. The rest must be taken in addition to the courses required for the major. Since a total of 22 hours are required, the minor causes the students to take 12 hours beyond what is need to graduate in their majors and would appear to cause students to remain in school at least an extra quarter. However, since most students take 5 years to complete their engineering degrees and usually have only one or two required courses in each of their last few quarters on campus, they can easily accommodate the minor courses without delaying graduation.

The Undergraduate Minor in Nuclear Engineering was approved in October of 2002. Any student who has the prerequisites for the first Nuclear Engineering course may enroll in the minor. The minor will be noted on the students' official transcript as long as she or he formally enrolls in the minor and completes the 7 courses, regardless of whether or not the students started taking the Nuclear Engineering courses before the minor was approved.

At Ohio State, any undergraduate minor must be approved by the University's Council on Academic Affairs and must be open to any student who meets the prerequisites. The process for getting the minor approved is straightforward but somewhat lengthy. First a formal proposal for the minor is written, and it must include a strong justification for the program. In the case of the

Undergraduate Minor in Nuclear Engineering, the justification was the nuclear industry's need for scientists and engineers with knowledge of nuclear science and technology and the declining number of university Nuclear Engineering programs. Then letters of concurrence with the proposal must be sought from departments across the campus. At Ohio State, letters were provided by the following departments: Civil and Environmental Engineering, Chemical Engineering, Chemistry, Electrical Engineering, Environmental Science, Geology, Industrial/Welding/Systems Engineering, Materials Science and Engineering, Mathematics, Mechanical Engineering, and Physics. The proposal must then be considered by the proposing college's Academic Affairs Committee. If the proposal is approved at the college level, it is sent to the University committee

Graduate Minor in Radiation Safety

Academic programs at Ohio State may offer graduate minors. Graduate students from any program may take a minor, with the approval of their advisors and the program offering the minor. The Graduate Minor in Radiation Safety was created to provide basic information on radiation science for students who think they might be working with radioactive materials either in a research laboratory or in the field. It is also designed to allow students to learn some of the basics of health physics, introduce them to the field, and prepare them for future study in the discipline should they decide to seek a career in the nuclear industry. Fifteen credit hours are required for the Graduate Minor in Radiation Safety. Students take 3 core courses and select 2 additional courses from a list of options. The courses are

Core

NE 505 Introduction to Nuclear Science and Engineering (3 credit hours)

NE 606 Radiological Safety (3 credit hours)

Options (select 3)

NE 742 Nuclear Radiations and Their Measurement (3 credit hours)

NE 743 Nuclear Radiations and Their Shielding (3 credit hours)

NE 771 Radioactive Waste Management (3 credit hours)

NE 880.05 Advanced Topics in Radiation Effects (3 credit hours).

The approval process for a graduate minor is similar to the one for the undergraduate minor. Departments whose students might find the Graduate Minor in Radiation Safety useful include those that supported the Undergraduate Minor and a few more. The additions include the interdisciplinary Environmental Science Graduate Program, Public Health, and a variety of departments within the School of Natural Resources and the College of Food, Agricultural and Environmental Sciences.

BS/MS Program

If an undergraduate student has a 3.5 grade point average (out of 4.0) and has completed at least 135 quarter credit hours (out of about 190 required for graduation in engineering), he or she may

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apply for the BS/MS Program. Under this program, students may take graduate level courses as technical electives and count up to 15 credit hours toward both the bachelors degree and the masters degree. The student's undergraduate program must, of course, approve the graduate level courses as technical electives. A student in the BS/MS program can complete as many as 15 of the 45 quarter credit hours required for an MS by the time she or he receives a B.S. degree. As a result, the student requires just one year beyond the B.S. to finish a masters degree, including writing a thesis.

Students in the BS/MS program may also receive 25% appointments as Graduate Research Associates. Thus, they can begin work on research projects in their senior years.

The Nuclear Engineering Program at Ohio State has frequently utilized the BS/MS program to recruit strong students for its MS program. Students in the BS/MS program are generally from other engineering programs. Most frequently, they come from Mechanical, Chemical, or Electrical Engineering. Graduates of this program are well prepared to work in the nuclear industry since they will have taken all the courses required of a nuclear engineering graduate student, and in addition, they hold a BS degree in another field of interest to the nuclear industry.

Dual Masters Degree Program

The Graduate School at Ohio State has long had a dual masters degree program. In this program, a student may earn two masters degrees simultaneously and in a shorter time than would be required to earn the two degrees sequentially. Up to half of the number of credit hours required for each degree may be "double counted." For example if Degree A and Degree B each require 50 credit hours. The student may take 25 credit hours of courses that apply to Degree A only, 25 hours that apply to Degree B only, and 25 hours that can be applied to both Degree A and Degree B. Thus the student takes a total of 75 credit hours rather than 100. In addition, the student may write a single thesis that is appropriate for both degrees. The student's advisory committee, composed of two faculty members from each degree program, must approve the courses and the thesis.

In the past, the dual degree program was of value to the student who really wanted to study Nuclear Engineering but needed to be prepared for another career if she or he could not find a position in the nuclear industry. Today, the nuclear engineering degree is generally considered to be of equal value. Students with dual masters degrees, one of which is in nuclear engineering, are exceptionally well prepared for research and management positions where in-depth knowledge of more than one technical area is desirable.

Marketing the Programs

Target audiences for these four programs include undergraduate and graduate students at Ohio State and incoming graduate students in a variety of disciplines, both within and outside of the College of Engineering. Although Mechanical, Electrical, and Chemical Engineering students and those from Engineering Physics are most likely to take advantage of the four programs, some

students from Civil & Environmental Engineering and the Environmental Science Graduate Program participate. Students learn about the programs by word of mouth, through the Nuclear Engineering Program's website, from the faculty member teaching NE 505, Introduction to Nuclear Science and Engineering, which is a popular technical elective for engineering majors, and from their advisors.

Providing information to advisors on the various programs related to nuclear engineering seems to be the single most effective way to raise awareness among undergraduate students. At Ohio State, each engineering department has an undergraduate advisor, or group of advisors, who help the students prepare their schedules at the beginning of the quarter. These advisors are often the students' most trusted source of information, and it is essential that they have details on the nuclear engineering programs. Most of the undergraduate advisors in the College of Engineering have been very eager to have information on the Nuclear Engineering Programs.

Graduate students, of course, are advised by graduate faculty members. The graduate faculty advisors are not always as quick to pass along information on the nuclear engineering programs as the undergraduate advisors. However, graduate students respond to research and funding opportunities. If the nuclear engineering faculty members are doing interesting research projects and have funding, strong graduate students tend to seek them out.

Summary

At The Ohio State University, four programs are being used to provide students in disciplines other than Nuclear Engineering with the background they need to be valuable employees of the nuclear industry. These programs are an Undergraduate Minor in Nuclear Engineering, a Graduate Minor in Radiation Safety, a BS/MS Program that allows a BS student in another field to get an early start on an MS in Nuclear Engineering, and a Dual Masters Degree Program that allows a student to simultaneously earn masters degrees in Nuclear Engineering and another field. In the past, students who were very interested in nuclear engineering but unsure of the employment prospects in that field used these programs to learn about nuclear engineering while preparing themselves for a career that would probably require knowledge of another field. Now, additional students are taking advantage of these four programs to prepare themselves for a career in the nuclear industry.

Biographical Information

AUDEEN W. FENTIMAN is Chair of the Nuclear Engineering Graduate Program and Interim Director of the Nuclear Reactor Laboratory at The Ohio State University. She previously served as an Associate Dean in the College of Engineering. Her research interests include radioactive waste management, environmental risk assessment, and engineering education.