Recruiting Graduate Students through an Introductory Nuclear Science and Engineering Course and a Newly Implemented Undergraduate Minor Program

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Introduction

Five years ago, an effort was undertaken in the Nuclear Engineering Graduate Program at The Ohio State University to re-invent the only undergraduate nuclear engineering course in the Program to make it a key recruiting tool for new graduate students. As this effort succeeded, it became apparent that additional success might be achieved if an undergraduate minor were established. Taking a little over one year from conception to University approval, the minor is now in place, effective Fall Quarter, 2002.

This fall, we can measure the success of these efforts by the increasing enrollment trends in all Nuclear Engineering core courses. Currently, expressed interest in continuing with nuclear engineering studies and/or employment exceeds the original goals of 3 – 5% for the Introduction course efforts by more than a factor of two.

Introduction to Nuclear Science and Engineering Course

Since the beginning of the Nuclear Engineering Program at The Ohio State University, an introductory course has always been part of the curriculum. This original course, designated Nuclear Engineering 505, was meant to be a first course that concentrated on nuclear reactor core design with a heavy dose of diffusion theory and reactor kinetics. It was designed to provide an in-depth basis for students to enter advanced courses in reactor statics and kinetics. For over 30 years, very little changed in this course – except the enrollment.

NE 505 was the only truly undergraduate course in the curriculum. Taught each Fall and Spring Quarter, it was expected to be the first course for students interested in nuclear engineering, and provided a brief overview with an emphasis on health physics and diffusion theory. By the mid nineties, as enrollments were dropping, so were the offerings of NE 505. In 1995 and 1996, the Spring Quarter offerings of 505 were cancelled. Finally, in 1997, the faculty decided that a change was needed. The course was no longer serving its purpose. It needed to be re-invented.

In Spring, 1997, with an enrollment of only four students (Minimum enrollments of 12 students are required for a faculty member to receive credit for teaching a course at the 500 (junior, senior, and non-major graduate) level.), continuation of the course was in jeopardy. However, it was decided not to cancel the course, but to drastically change the syllabus in real time as it was being taught to this small class.[1]

The primary change was to introduce the breadth of nuclear engineering applications, beginning with a brief history of nuclear science, and following this with a discussion of

the many applications of nuclear science that impact each of us on a daily basis. This is followed by an introduction of radiation, where it comes from, how it interacts with matter, including living beings, and how and if we need to protect ourselves from it. Only then are reactors discussed. A very brief diffusion theory based development of reactor core design, size determination, and reactor operation is presented. The course ends with discussions of waste management, industrial applications including sterilization and food irradiation, and relative risk in our lives.

Several tours are included during the quarter. A key early tour is of The Ohio State University Research Reactor where the students perform a reactor startup, irradiate aluminum foils, identify the isotopes produced, and measure the half life of the Al-28. They use a gamma-ray spectroscopy system and a GM detector and see other radiation detectors normally used in most reactor and radiation facilities.

A second tour is of an operating nuclear power plant. This has proved to be the most popular of the tours even though the students must give up a Saturday to participate. Since 9/11/2001, we have had difficulty scheduling this tour as part of the course, but we hope it can be reinstated in the future.

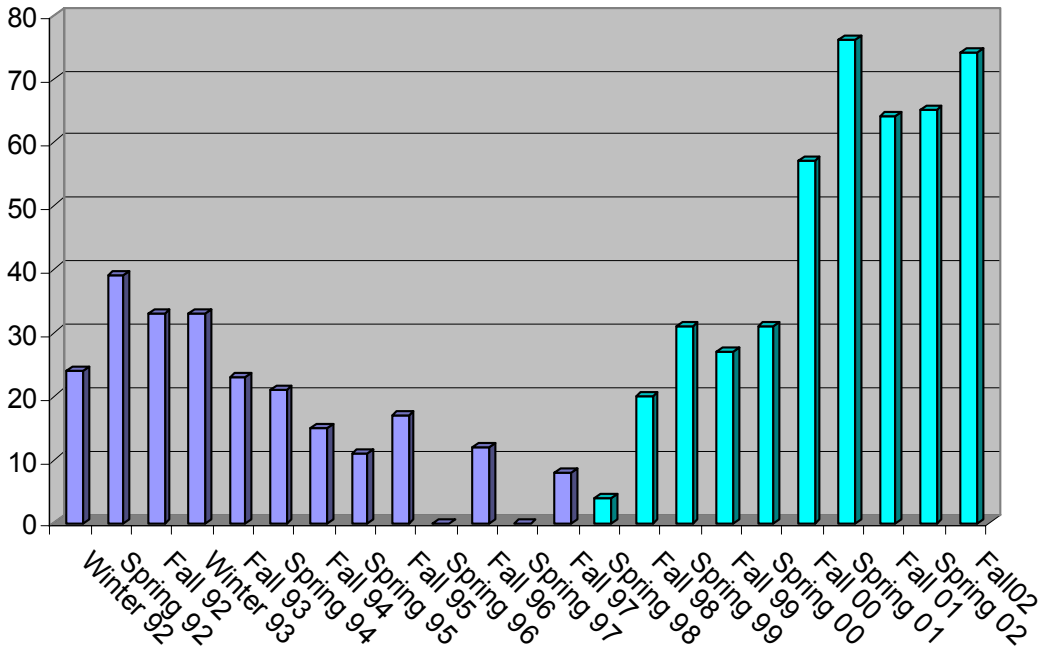
Another tour is of the James Cancer Hospital Radiation Diagnostics and Therapy Department. Here the students not only see the equipment used, but are able to perform a measurement experiment.

An optional tour is of the Steris Isomedix radiation sterilization facility in Columbus, Ohio. Many different products including baby bottles and nipples, medical equipment, cereal and juice boxes, and golf balls are irradiated in this Co-60 facility. The operators shut down the irradiator for the tour and the students are able to enter the irradiator and view the Co-60 rods through about 20 feet of water.[2]

These changes have been successful in attracting a large number of students to the course. Enrollment figures for the past ten years are shown in Figure 1. This figure shows the trend prior to the change, and the success since the change was made. The enrollment is expected to remain somewhat static around 70 – 75 students due to limitations on the capacity of the classroom being used. Also, with many more students, the tours would be very difficult to handle.

Not shown in Figure 1 are the enrollment figures for Spring Quarter, 2003. At the time of this writing, 80 students are enrolled with an additional four on the wait list. The course is cross listed in Mechanical Engineering which attracts the largest percentage of registrants. However, it also draws from other engineering disciplines and it's interesting to consider the mix that includes undergraduate majors in Chemical Engineering (16), Electrical Engineering (2), Environmental and Civil Engineering (13), Engineering Physics (1), Engineering Undecided (4), Materials Science and Engineering (2), Mechanical Engineering (37), Nuclear Engineering (Graduate Program) (1), Physics (1), and Welding Engineering (3). This mix changes each quarter and is thought to be partially due to student schedules in their majors. For instance, typically more Materials Science majors are enrolled in the fall, and relatively few Chemical Engineering majors are enrolled in the fall. Also, our experience is that in the first two weeks after the quarter begins, we generally lose as many as 10 students, usually due to schedule conflicts.

Figure 1. Enrollment /Academic Quarter for the Introduction to Nuclear Science and Engineering Course

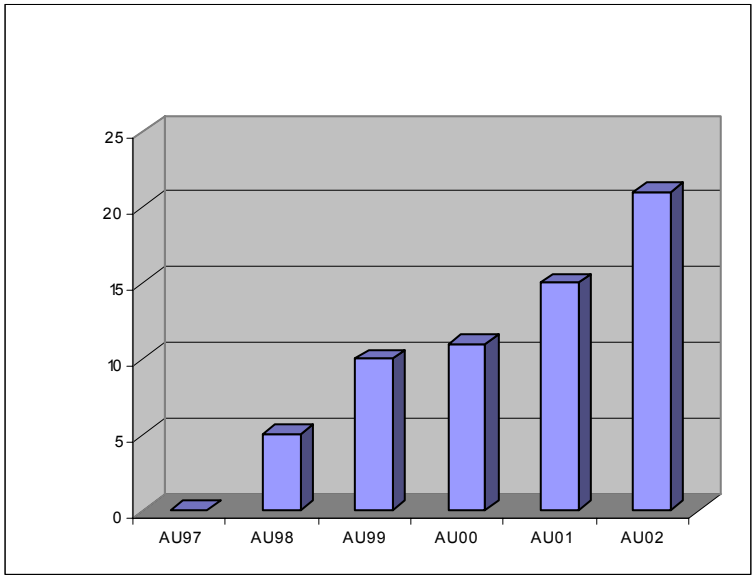


Impact on Follow-On Courses

We have seen a steady increase in enrollments of higher level courses that are attributed, in part, to the recruiting success of the introductory course. Not only have the enrollments had a positive impact on credits for teaching, but they have started to have a positive impact on the graduate program itself as students choose to continue their education programs at the graduate level in nuclear engineering.

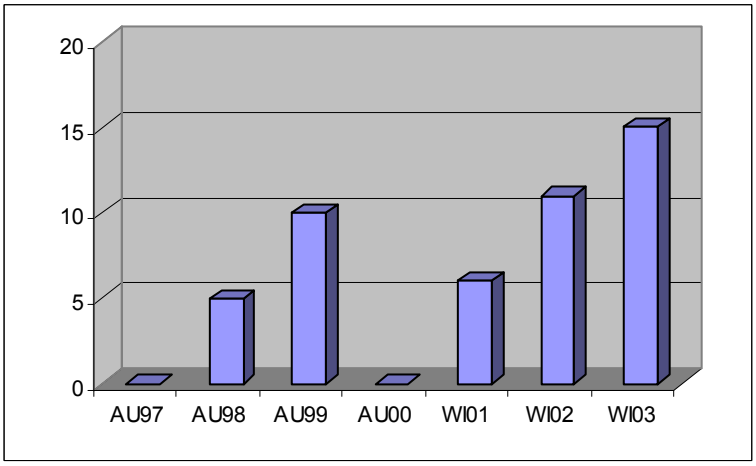
Data for the first two courses that follow NE 505 are shown in Figures 2 and 3. Logically the first course in the normal sequence is Nuclear Engineering 606, Radiological Safety. Many students take this course concurrently with NE 505 since both are offered in Fall Quarter.

Figure 2. Enrollment /Academic Quarter for NE 606 Radiological Safety



The next course in the normal sequence is Nuclear Engineering 708, Reactor Theory. This course is offered during Winter Quarter. The enrollment history for this course is shown in Figure 3.

Figure 3. Enrollment /Academic Quarter for NE 708 Reactor Theory



From these last two charts, it can be seen that the nuclear engineering faculty had suffered for several years with receipt of reduced teaching credits. During the quarters that the advanced courses were not taught, the faculty were obligated to teach Mechanical Engineering. This resulted in an application of nuclear engineering energies in an area outside of our core interests.

Our goal is to assure the enrollment trends continue, and along with other initiatives, full credit for teaching courses in the Program should be achieved in the future. Additionally, as enrollments in the Graduate Program increase, nuclear engineering research will be performed by our own students rather than students imported from other disciplines.

Opportunities for Nuclear Engineering Education at Ohio State

Several opportunities exist at Ohio State for students to study nuclear engineering. These are organized into four programs:

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

The newest of these is the undergraduate minor in nuclear engineering, approved in the fall of 2002. A major justification for this program is the success of NE 505 in demonstrating the interest of students in nuclear engineering.

These four options for studying nuclear engineering are detailed and discussed in another paper at this conference.[3]

Summary

The Introduction to Nuclear Science and Engineering course at The Ohio State University has proven to be a valuable recruiting tool for both the newly implemented undergraduate minor program and for the graduate program. Enrollments have steadily increased and now are being sustained at the enrollment limits established due to classroom size restrictions. The course has become a service course for the Mechanical Engineering Department, with more than half the enrollment coming from outside the Department.

References

1. "Succeeding With a Service Introductory Course in Nuclear Science and Engineering," by Brian K. Hajek. Transactions of the American Nuclear Society 2000 International Meeting, Washington, D.C., November, 2000. Volume 83.

2. "Popularizing a Nuclear Engineering Course for the Masses," by Brian K. Hajek. Transactions of the American Nuclear Society 2001 Winter Meeting, Reno, NV, November 2001. Volume 85, pg. 457.

3. "Preparing Versatile Engineers for the Nuclear Industry," by Audeen W. Fentiman. Transactions of the ASEE 2003 Meeting.