Evolution of Nuclear Engineering and Radiation Health Physics at Oregon State University

Andrew C. Klein and Stephen E. Binney
Oregon State University

The Department of Nuclear Engineering at Oregon State University (OSU) has consistently evolved and broadened its scope over the years to respond to changes in the research and curricular demands of the nuclear community. The changes to meet these demands have tended to be made gradually over time and after considerable thought and reflection.

The Department was originally established as a separate, stand-alone department in 1972, although nuclear engineering courses had been offered since 1957 in the Department of Mechanical Engineering. The first nuclear engineering program at OSU was the B.S. degree which was approved for delivery by the Oregon State System of Higher Education in 1968. The undergraduate degree program in nuclear engineering remains a vital part of the educational mission of the Department. Graduate degree programs at both the M.S. and Ph.D. levels were added one year later so that by the end of the 1960s, the full suite of degree programs (B.S., M.S., and Ph.D.) were offered in Nuclear Engineering.

A major curriculum revision also occurred in 1972, concurrent with the development of a four-year B.S. degree program in Nuclear Engineering Technology (NET). The NET program played a very important role in the Department for approximately nine years, until it was suspended in 1981. A total of 84 B.S. degrees in Nuclear Engineering Technology were awarded at OSU between 1972 and 1981. The suspension of this degree program was in large part due to limited financial support and to a misunderstanding by industry of the difference between a B.S. level NET graduate and a two-year trained nuclear technician.

Separately, a Radiation Health program functioned in the General Science Department of the College of Science at OSU from 1963 to the late 1980s. During this time the program transitioned from an x-ray technology program to a modern health physics program. Due to a dwindling nuclear-oriented faculty and an overall reduction in interest in this educational area in the General Science Department, the M.S. program was transferred in 1988 to the Department of Nuclear Engineering. In 1991 the B.S. program was also transferred. The Ph.D. component was added to the Radiation Health Physics program in 1997. Thus, presently the compete series of undergraduate and graduate offerings are now available at Oregon State in both Nuclear Engineering and Radiation Health Physics.

The undergraduate Nuclear Engineering program has been accredited by EAC/ABET since 1973. It is the only such accredited program in the Pacific Northwest and one of only two such degree programs on the west coast. The curriculum is both broad in scope and extensive in depth. Nuclear Engineering courses comprise 32% of the required 192 quarter credit hours. Other engineering, mathematics, and science courses constitute 46% of the curriculum, with the remaining 22% being liberal arts related. Primary components of the nuclear engineering courses

include radiation physics, radiation detectors and instrumentation, radiation safety, radiation dosimetry, nuclear regulations, nuclear fuel cycle, nuclear reactor analysis and laboratory, thermal hydraulics, and nuclear system design.

In contrast to the Nuclear Engineering curriculum, the undergraduate Radiation Health Physics program is less math-intensive and focuses more on the biological aspects of nuclear technology, although many of the nuclear courses are common between the two programs. Nuclear Engineering and Radiation Health Physics courses make up 25% of the required 192 quarter credit hours. Health, biology, physics, zoology, and chemistry courses constitute 52% of the curriculum, with the remaining 23% being liberal arts related or free electives. Specifically, in the Radiation Health Physics major there is a focus on radiation physics, radiation detectors and instrumentation, radiation safety, nuclear regulations, nuclear fuel cycle, radiation biology, radiation dosimetry, human anatomy and physiology, statistics, epidemiology, and industrial health.

In addition, since about 1995, a student majoring in Radiation Health Physics can also pursue a pre-medicine track by replacing a set of restricted electives with the same set of organic chemistry, cellular and molecular biology, genetics, and biochemistry courses that other pre-medicine students take. This option allows students considerable flexibility in their career choice should their plans to enter medical school change for any reason. We expect to see an increase in students enrolling in this special program as more prospective students become aware of its existence.

Also, students entering the Nuclear Engineering and Radiation Health Physics degree programs from states that participate in the Western Undergraduate Exchange (WUE) program can attend OSU at a reduced tuition rate (compared to the full out-of-state tuition rate). Currently, about 10 to 15 percent of the undergraduate students in the Department are WUE students from Hawaii, Alaska, Idaho and other western states.

The Department is housed in the OSU Radiation Center, an instructional and research facility designed to accommodate programs involving the use of radiation and radioactive materials. The Radiation Center works with internal and off-campus instructional and research programs involving nuclear engineering, nuclear science, radiation chemistry, radiation protection and related areas. The Radiation Center includes a 1.1 MW thermal TRIGA Mark II with pulsing capability, multiple irradiation facilities (pneumatic transfer, rotating rack, beam ports, thermal columns), and a static and high speed motion picture radiography facility capable of taking still or very high speed radiographs. The Radiation Center also houses a small technical library and the Department maintains two computer laboratories.

Since 1993 the Department has performed research on a 1/4 length scale thermal hydraulics facility designed to test the passive performance of Westinghouse Electric Company's AP600 advanced reactor design and to benchmark advanced thermal hydraulic computer codes. This facility, known as APEX (for **A**dvanced **P**lant **Ex**periment), is a two loop design with four cold legs and two hot legs. The reactor core consists of 48 electric heater rods operating at a maximum power of 600 kW. Four canned motor pumps are used to circulate water in the

primary loops. All of the safety systems and plant logic in the AP600 design have been built into the APEX facility. Over 750 instruments monitor the plant response to the simulated accident.

Because of the importance of retaining students once they enter the program, Nuclear Engineering faculty maintain close contact with the undergraduate students in the Department each term. The two curricula have been designed to include at least one course each term in the Department for all students in either program. All classes are held in the Radiation Center, which is located on the western edge of the OSU campus, away from all other College of Engineering facilities. By having all of the classes in the Radiation Center we are able to provide students with a "home away from home" atmosphere which brings them into regular contact with the faculty, staff and graduate students.

The two programs have different areas of focus at the graduate research level. The Nuclear Engineering program focuses primarily on nuclear power reactors, thermal hydraulics, reactor design and analysis, computational methods, reactor safety, and radiation applications. The Radiation Health Physics program deals mainly with environmental radiation monitoring and pathway analysis, radioecology, applications of nuclear techniques, nuclear medicine, applications of research reactors, radiation detection and measurement, radioactive waste management, radiation dosimetry, and radiation shielding. The evolution of these research areas over the years has been driven by changes in research emphasis by government and industry and the particular interests of the faculty.

Over the past two and a half decades three significant factors have characterized the OSU Department of Nuclear Engineering. The first is the drop in undergraduate enrollment from a high of 133 in the late 1970s to the current 62 in the two programs as seen in Figure 1. A second trend is the shift in curricular and research focus toward the direction of radiation science and health physics which began in the mid-1980s. Even before the Radiation Health Physics program was incorporated into the Department, faculty from Nuclear Engineering supervised graduate students in this program and taught a majority of the courses. Figure 2 shows the historical trends for degrees awarded at the undergraduate level in the Department. Currently, approximately 50 percent of the students in the Department are enrolled in the Radiation Health Physics at both the undergraduate and graduate levels. This diversity of course and degree offerings has allowed the Department to manage the fall off in enrolments over the past few years that has been seen by other nuclear engineering programs across the country. In fact, undergraduate enrollment went up in the 1997 Fall term due to the largest freshman class in recent memory. In 1997 there were more B.S. degrees awarded in Radiation Health Physics than in Nuclear Engineering. Figure 2 also demonstrates the rapid rise and fall of the Nuclear Engineering Technology degree program in the 1970s, and the recent increase in student interest in the Radiation Health Physics area. The third significant factor has been faculty recognition and the dynamic growth in the thermal hydraulics and health physics areas research areas. Two of the last three winners of the Elda E. Anderson Award by the Health Physics Society have gone to faculty in the Department, and Figure 3 shows the recent rise in research funding and productivity for the Department. The large increase in external funding since 1992 is attributed to the construction and testing conducted in the APEX facility, with the Department averaging close to $2.0 million per year.

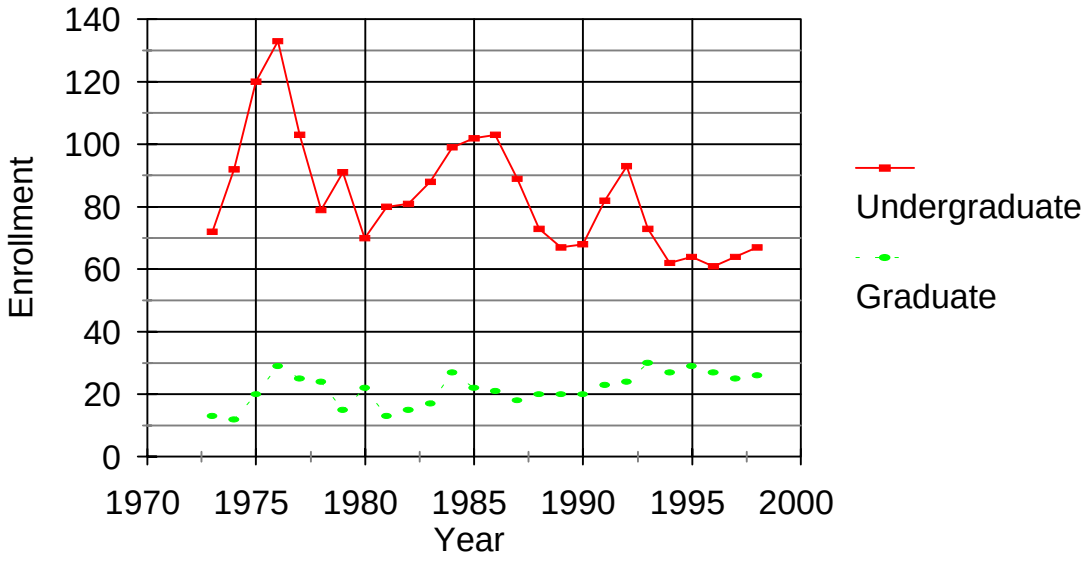
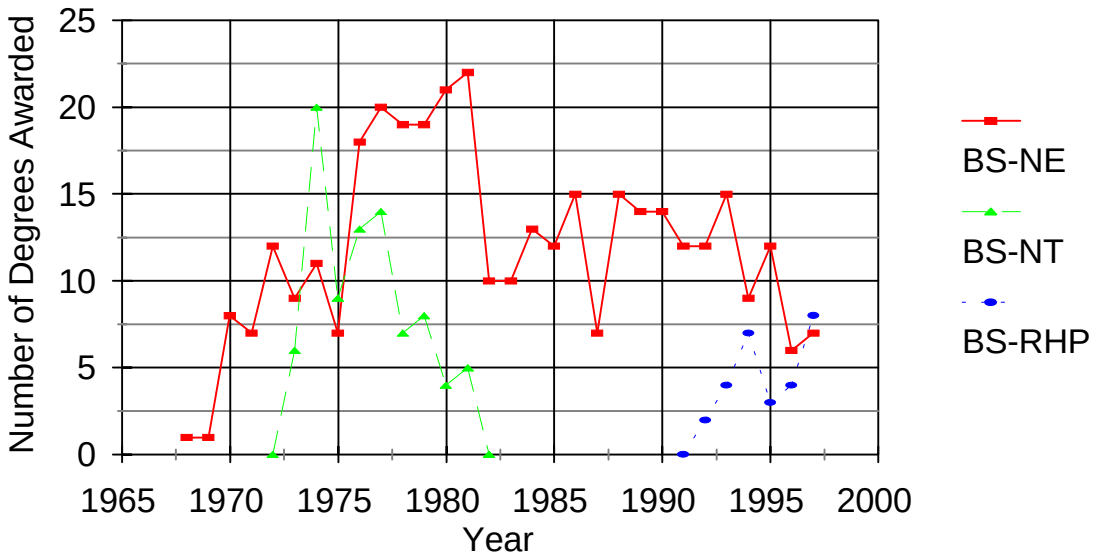


Figure 1. Undergraduate and graduate enrollments at Oregon State University.



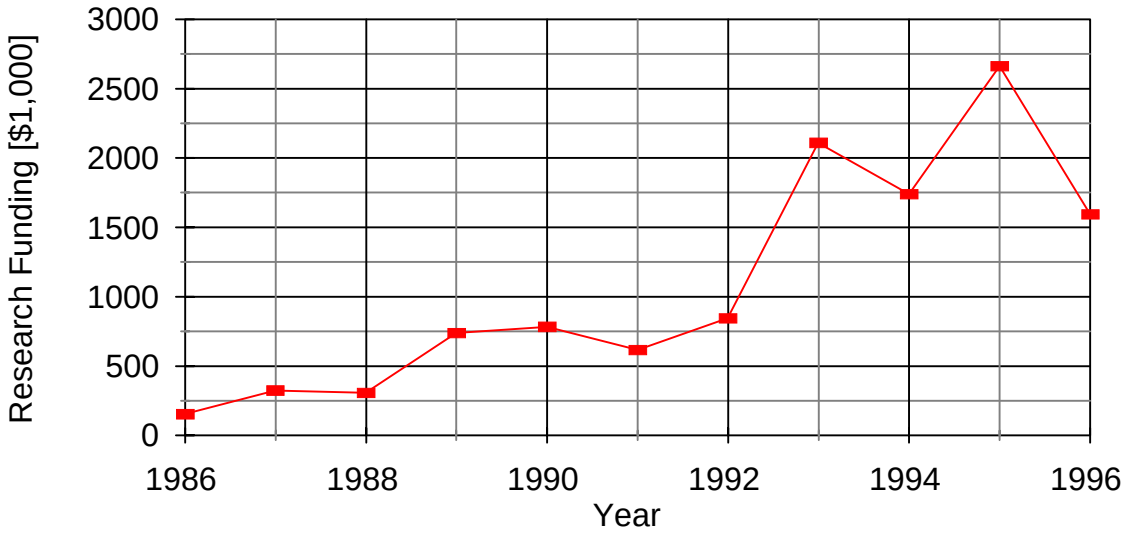


Figure 2. Undergraduate degrees awarded at Oregon State University 1968 - 1997.

Figure 3. Oregon State University Nuclear Engineering research funding 1986-1996.

The Department realized long ago that the focus of a nuclear engineering department had to be much broader than nuclear power for electricity production. This became especially important when the Trojan Nuclear Power Plant, the only nuclear unit in Oregon, closed in 1992. Consequently a faculty staffing plan was implemented to develop and maintain expertise in several varied nuclear areas of curriculum and research. This approach has significantly strengthened the Department. Currently the Department has three full-time (one senior and two junior) faculty members in the traditional reactor engineering and thermal hydraulics areas, one full-time (junior) and two part-time (senior) individuals primarily associated with the health physics area and one full-time and two part-time (all senior) faculty who overlap both areas. In the past four years the Department has hired three new faculty members, one in each of the three important areas of health physics, numerical methods development, and thermal hydraulics. This staffing plan, and the opportunity to hire outstanding individuals in these three important research and curricular areas, gives the Department a strong sense of direction as we move into the 21st century.

ANDREW C. KLEIN is Department Head and Professor of Nuclear Engineering at Oregon State University. He received his Ph.D. in Nuclear Engineering from the University of Wisconsin, Madison and his research interests include nuclear arms control technology, transient phenomena in advanced nuclear power reactors, space reactor analysis and design, and radiation shielding and health physics.

STEPHEN E. BINNEY is Professor of Nuclear Engineering at Oregon State University. He obtained his Ph.D. in Nuclear Engineering from the University of California, Berkeley. His primary research interests involve innovative application of nuclear techniques.