AC 2008-1441: MATRICULATING NUCLEAR ENGINEERING STUDENTS: THE NORTH CAROLINA STATE UNIVERSITY CASE

Lisa Marshall, North Carolina State University

Ms. Marshall is the nuclear outreach instructor for the Department of Nuclear Engineering at North Carolina State University in Raleigh, N.C. She is currently the chair of the ASEE – Nuclear and Radiological Division, the education committee for the American Nuclear Society – Eastern Carolinas Section and NC State's Provost Advisory Council on the Status of Women. Her research interest lies in engineering studies and science policy; a doctoral student at the University of North Carolina-Chapel Hill.

Mohamed Bourham, North Carolina State University

Dr. Bourham is the interim department head and professor in the Department of Nuclear Engineering at North Carolina State University in Raleigh, N.C. His research area lies in plasma-matter interactions, from interaction with solids to liquids to energetic combustible materials to fabrics and micro-organisms. Dr. Bourham is also an affiliated professor in the joint Department of Biomedical Engineering, N.C. State University and the University of North Carolina at Chapel Hill. His biomedical research areas include biomedical imaging, fluid dynamics, mathematical modeling, and medical imaging.

Matriculating Nuclear Engineering Students – The North Carolina State University Case

Lisa Marshall and Mohamed Bourham
Department of Nuclear Engineering at North Carolina State University

Abstract
First-year nuclear engineering students typically complete a common freshman year that does not include courses(s) in nuclear engineering. How then does a department engage students who have expressed their intent to major in nuclear engineering but haven't matriculated into the discipline as of yet? Through an analysis of matriculation trends and a survey of current nuclear engineering students, we will report on why students choose nuclear engineering, what makes them stay, and what impact current retention programs for un-matriculated students have on their decisions? Students surveyed provide insight into factors they deem important and subsequently have an effect on their commitment to a nuclear engineering education at North Carolina State University.

Key Words
Nuclear engineering; first year engineering; undergraduate program

N.C. State's Department of Nuclear Engineering has seen a 74% increase in the undergraduate student population from 37 students in 2000-01 to 143 students in 2007-08. The portion of un-matriculated students in the department has increased by 55% over the same eight year timeframe, from 15 in 2000 to 52 in 2007. For 2007-08, the percentage of un-matriculated students in the undergraduate population stands at 36%. There are larger numbers of admitted students expressing their intent to major in nuclear engineering. Since most un-matriculated students have not taken a course in their desired major, the department must rely on (non) academic retention programs to assist students in matriculation – a crucial step to progress towards degree completion that students must navigate. Ultimately, it impacts the supply side of the increasing employment demand for nuclear engineers.

Why students choose nuclear engineering; why do students continue in this major; and, what retention programs they value become crucial questions to understanding some of the variables that impact the nuclear engineering student body. A project in progress, this paper reports on initial observations.

Matriculation - Progress towards Degree

Nuclear Engineering enrollment figures have increased over an eight year period by 74% (Figure 1), and the number of un-matriculated students (students showing an intent to major in nuclear engineering) has increased 55% from 15 to 52 (Figure 2). Over this same period, the portion of the entire undergraduate student body these numbers represent has remained relatively consistent, between 31% and 41%.

Figure 1: Nuclear Engineering Undergraduate Enrollment

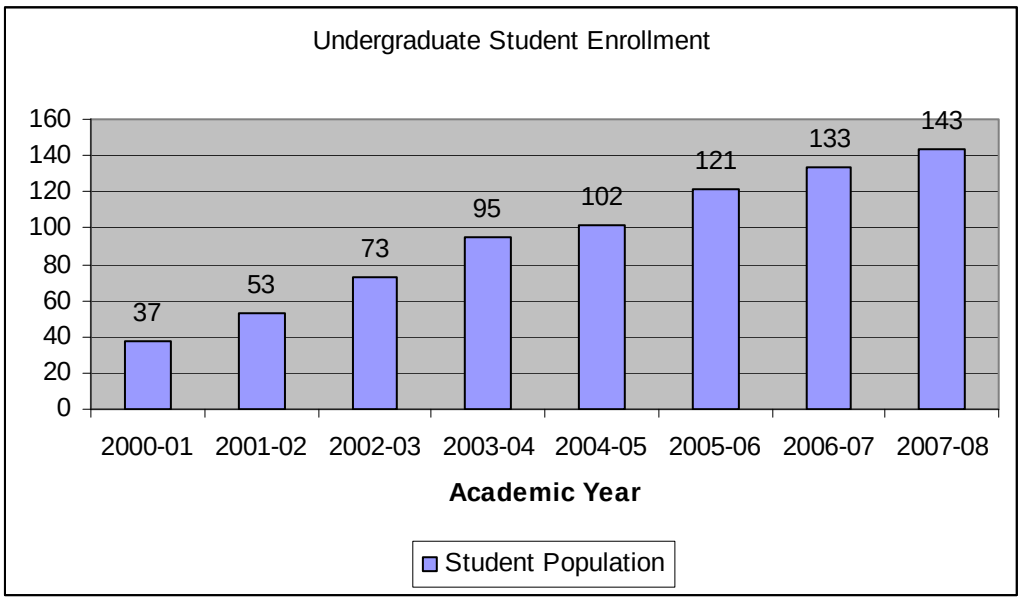
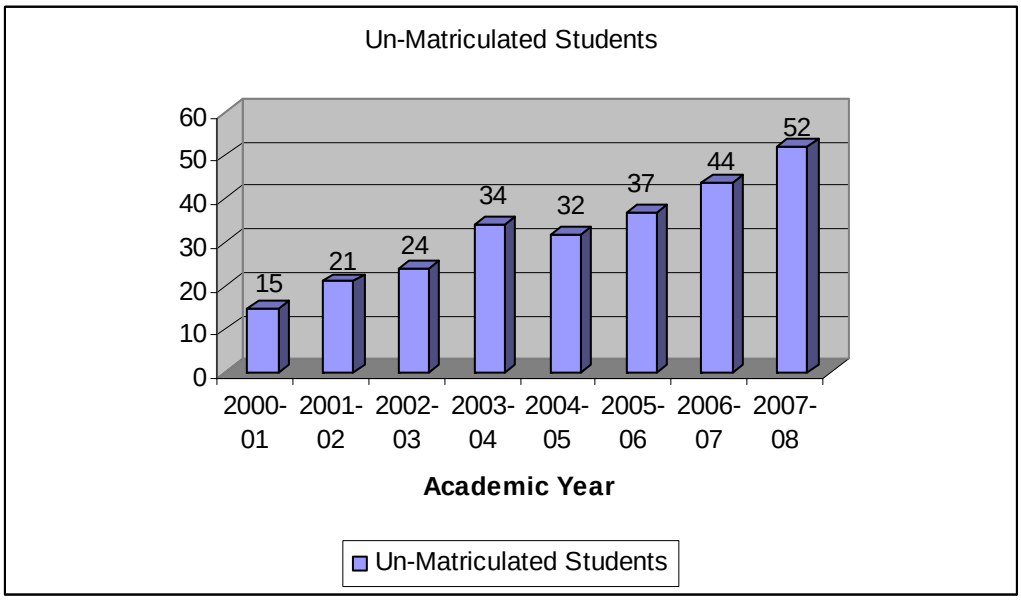


Figure 2: Nuclear Engineering Un-Matriculated Student Body



In 2007-08, un-matriculated students account for 38% of the undergraduate student body. Engagement with these students is critical. They must successfully complete a specific series of courses in less than 60 credit hours, with an overall grade point average (GPA) of 2.9 and above for automatic matriculation while a GPA between 2.5 and 2.89 will be reviewed.[1] Ultimately, this is the second key step after admission into engineering that students must navigate. Since most un-matriculated first-year students will not have taken the nuclear engineering survey course (Introduction to Nuclear Engineering), it is imperative that there be opportunities for students to engage with the department.

Engagement with Un-matriculated Students

Student success literature points to the need for content specific material and its relevance to real-world applications as one of the key steps in forging alliances to what a student studies.[4,5] In the case of the un-matriculated student, this takes the form of an introductory course in engineering and problem solving. Within this course students engage engineering through discipline exploration, career development, and a freshman design project. There are on average seven projects ranching from concrete canoe construction to a Rube Goldberg project to an ergonomic design project to nuclear engineering's reactor probe project.[6] The nuclear engineering project provides students with an opportunity to design, build and test a light-sensitive monitor in the research reactor within the department. Cherenkov radiation is the guiding principle explained to students, who then must decide on the appropriate monitor to measure reactor power output. A mystery power level is tested and students must accurately calculate, within two percent, this level. In 2007-08, there were eight teams of four students each who chose this freshman design project.

Of the eighteen academic engineering programs offered at North Carolina State University, nuclear engineering is one of the few departments that directly advices its un-matriculated students. They are assigned to the Nuclear Outreach Instructor. The instructor engages with students through the admissions process, is seen at open houses, in-class science visits, and speaks with students and parents during departmental tele-counseling. Upon acceptance into the program, as part of engineering new student orientation, there is an opportunity to interact with a departmental representative. A department specific orientation session supplements the college level session where students are walked through first semester courses, advance placement procedures, matriculation requirements, and how to become connected early on with departmental research, and the student chapter of the American Nuclear Society (ANS). A career development series is provided in-house and through the University Career Services. This smaller session allows students follow-up time in a smaller setting (college-level orientation serves 1400 students whereas department orientation serves 52). A facility tour that connects future course work and technological application is provided – visits to research reactor, neutron activation analysis, radiation teaching laboratory, and plasma laboratory. They also hear from current students about their experiences and suggestions for a "smoother" transition to university.

Semester and freshman summer research opportunities are also integral to student engagement. In the spring semester they apply and express interest in general thematic areas within nuclear engineering. Faculty members then choose students, based on funding availability, to work on research projects. Themes in the past have included atmospheric plasmas, waste management, thermal hydraulics, and nuclear materials. Students interact with senior undergraduate and graduate students, learning the process of primary research and use of laboratory equipment. Sample spring 2007-08 semester research topics include nuclear materials and reactor physics. This research opportunity may continue on through the summer months or new projects developed.

Student Views on Nuclear Engineering

A regular polling of the student body is necessary to access the effectiveness of outreach and engagement activities. As such an anonymous survey was taken of nuclear engineering students. The questions asked tried to get at why nuclear engineering was chosen, reasons for continuing in nuclear engineering, and experiences with retention programs – both within the department and industry (for example, summer internships and co-operative education). Response rate, as of February 29 enrolment figures, was 50% (68 out of 136); 35% were sophomore, 32% were senior, 18% were freshman, and 15% were junior students. The following are themes gleaned from the survey:

Why did you choose nuclear engineering?
Themes included:

- Taking different career path to siblings/parents
- Challenging subject matter
- Future career opportunities
- High school academic camp, Young Investigators' Summer Program
- "Good idea at the time"
- Nuclear energy's role in alternative fuel prospect
- Opportunity within navy
- High school science classes
- "Conned"
- Use of their math and physics skill-sets
- Switch from Physics as a major, more applicability
- Interest in plasma engineering
- "Cool" factor
- Good money

Why continue in nuclear engineering?
Themes included:

- Solid career opportunities (including with the Navy)
- Quality of program: faculty/staff at N.C. State University
- Challenging/rewarding of subject matter
- Plays on academic strengths (e.g. math and physics)
- Promise of high paying position
- Diverse applications of nuclear engineering (including alternative fuel source)
- Internship opportunities

- Small welcoming department (e.g. class size, personnel)
- “Too far into it to quit”/Not a quitter
- Pride in saying nuclear engineering student (“the few, the proud, the nukes”)
- Plasma applications
- Supportive staff
- “The renaissance is coming”
- Societal impact

Rate your experience with summer internships, summer research, academic year research, freshman design, co-ops

- Internships favored (with excellent then neutral experience reported)
- Summer research (with good then excellent experience)
- Academic year research (with excellent experience)
- Good co-op experience

Closing Remarks

This case study provides insight into quantitative and qualitative data needed to access current initiatives. Visitation programs and nuclear engineering curriculum development play a vital role in students’ initial contact with the field, especially within high school science classes. The conveyance of challenge and future opportunities impacted their decision-making process to pursue nuclear engineering. These variables were followed by nuclear energy content and career salaries respectively.

It is important to reinforce the challenge of and career opportunities within the field as these variables were cited as reasons for their continuance in the academic program. The quality of the program and its personnel (faculty and staff), high salary ranges and not wanting to appear as a quitter were second tier reasons given. Societal importance (including alternative fuel source, solving environmental problems and overall “big” impact of the discipline) was cited as significant as well.

Summer internships are the preferred retention program followed by academic research. An increase to these opportunities will be pursued.

This study represents an initial tracking of NC State’s nuclear engineering program. It is our intent to expand this survey to include recent alumni. More detailed questions in a follow-up survey will be administered to the undergraduate student population in the hopes of probing what aspect of the discipline is of interest, gender and ethnic experiences within the program, and exit surveys with students that leave before matriculating, opting for other engineering majors. It is not sufficient for enrollment numbers to increase thus the need for outreach and retention programs that link given reasons for attraction and continuance in NC State’s nuclear engineering undergraduate program.

Bibliography

[1] Students must complete CH 101, CH 102, E 101, ENG 101, MA 141, MA 241, and PY 205 with a C – or higher, and E 115 satisfactorily (S). (English requirement depends upon semester of first enrollment, and may be satisfied by ENG 101 or ENG 111Z or ENG 111/112).

[2] Astin, A.W. *What Matters in College: Four Critical Years Revisited.* San Francisco, Jossey-Bass, 1993

[3] Hayward, G.C., B.G. Brandes, M.W. Kirst, and C. Mazzeo. *Higher Education Outreach Programs: A Synthesis of Evaluations*. Sacramento, CA: Policy Analysis for California Education, 2005.

[4] Malicky, David. "Problem, Project, Inquiry or Subject-Based Pedagogies: What to Do" *Proceedings of the American Society for Engineering Education Annual Conference & Exposition*, 2008

[5] Smith, K.A. et al. "Pedagogies of Engagement: Classroom-Based Practices", *Journal of Engineering Education*, volume 94 (1), 2005: pp. 87-101

[6] Refer to http://courses.ncsu.edu/e101/lec/001/ for further details.

[7] Sallee, Margaret and William G. Tierney. "The Influence of Peer Groups on Academic Success" in *College and University Journal*, volume 82 (2), 2007: 7-14

Biographical Information

LISA MARSHALL

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MOHAMED BOURHAM

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