

2016 ANS WINTER MEETING

# Nuclear engineering programs: Successes and challenges

*Increasing interest in nuclear as zero-emissions energy has boosted nuclear engineering education throughout the United States.*

A panel session titled “Building a Nuclear Energy and Science Education Program: Successes and Challenges of Developing a Vision for Nuclear Energy Education” focused on the successes achieved and challenges faced by colleges and universities in the process of developing a nuclear engineering curriculum. Speakers at the session, which was organized by the ANS Education, Training, and Workforce Development Division, included faculty from a number of nontraditional nuclear programs who shared their strategies for and experiences with establishing a nuclear curriculum.

Andrew Thomas, review coordinator for the Innovative Nuclear Research Integration Office at Idaho National Laboratory and organizer of the session, opened with a brief overview, including the challenges and opportunities that the renewed interest in nuclear has presented. “The resurgence in nuclear has resulted in growth in traditional university power players, Department of Energy and Nuclear Energy Institute funding, and national laboratory research and analysis,” he said, “but it has also resulted in the growth of nuclear more broadly in universities and in institutions across the nation.” He addressed the challenges faced by faculty members at universities and colleges without nuclear engineering programs and the hurdles they often have to clear to institute a program at their respective institutions. “Some of these programs began with a few motivated faculty,” he said, “while others have a specific regional reason for why they started. I believe that the experiences discussed here today will be relevant to all stages of growth . . . whether it’s a large or small program.”

## Challenges at Utah State

Heng Ban, a professor of mechanical and aerospace engineering at Utah State University (USU), followed Thomas’s introduction by noting the struggles that his department currently faces. According to Ban, the university as a whole is an agricultural university, but also has strong programs in space, biology, and economics. The student population consists of 25,000 undergraduate and 5,000 graduate students—“a typical state school,” he said. The Mechanical and Aerospace Engineering Department is relatively small, with about 100 faculty members on tenure track. For aerospace engineering in particular, Ban said, the 15 tenure-track faculty members often end up teaching classes of 130 students, making for a heavy exam-grading load. The department received approval two years ago to add master’s and Ph.D. programs for aerospace engineering, and it averages \$2 million per year in research expenditures. “Around 2000 or so, we got a new dean who said if you don’t do research, you don’t get tenure,” Ban said. “We have 10 people hired after 2000 doing the majority of the research. That’s why I say it’s a small number, but it’s actually pretty good in terms of a growing and developing program.”

Ban listed the two main challenges for his department at USU: Nothing can be labeled as nuclear, and the faculty-to-teaching load ratio remains high. “We cannot put ‘nuclear’ in any of our programs, not even our research lab,” he said, adding that as a faculty member, he can state on his website that he does nuclear research, but no programs or educational courses can have “nuclear” in their names.

Ban said that the resistance comes when a proposal to rename anything “nuclear” reaches the state level. “We can do the research—nobody can stop us,” he said, “but we cannot have any official designation as nuclear.” As for the teaching load, Ban said that each faculty member typically teaches two courses a year, but they are dealing with larger class sizes.

Trends in the industry and the area look promising for the university’s nuclear research, according to Ban. “Our student population is mostly from Utah, and they are all for nuclear,” he said. “They are not from big cities and other places that are pretty much against nuclear. And we hired a young, enthusiastic group of research-strong faculty, so that’s a good thing in our department—a group of young people pushing hard to get research done.” Also, Ban said, USU is only about two hours from INL by car, so the department and the students are able to visit the lab, and they stay in touch through individual electronic communications.

Ban emphasized that his department is aiming to make a “creative space” for nuclear, but work is still under way to figure out the best way to do this. “We started with research,” he said. “We synchronized our thinking and then said, ‘Let’s go for it.’ We wrote proposals and were fortunate enough to get funded [to the point] that at one time we had three projects going within the department. Now, more than half the research done in the department is nuclear.”

The majority of students in the department belong to the Church of Jesus Christ of Latter-day Saints, making Ban’s department a nontraditional university department. Out of 100 students, maybe five are women, Ban noted. Half of the students are married, and about a third of them have children. “They are very serious in terms of their goals. . . . When they apply for fellowships and scholarships, they are very successful,” he added. Ban said that the department has applied to the Nuclear Regulatory Commission for development programs to help younger faculty members, and those within the department, including students, are very active in pushing for nuclear in Utah.

### Growth and success at VCU

Sama Bilbao y León, associate professor and director of nuclear engineering programs at Virginia Commonwealth University, followed Ban, speaking of her experience with nuclear at VCU. The university, located in Richmond, is the largest public university in Virginia, with 32,000 students overall. “We have a lot of nontraditional students—a lot of veterans, people with associate degrees who work for a few years and then decide to come back, people with kids,” Bilbao y León said.

VCU is over 200 years old, but the College of Engineering is only 20 years old, having been established in 1996. Bilbao y León said that the College of Engineering at VCU is “exploding,” noting that the number of faculty has doubled in the last four years.



Bilbao y León

As for nuclear engineering at VCU, “In 2007, some of us had this crazy idea of starting a nuclear engineering program,” Bilbao y León said. “There were no nuclear engineering programs in Virginia, yet we had tons of nuclear infrastructure,” she said. “We have Areva, a national accelerator facility, NASA, Dominion, the nuclear navy. . . . We have all these stakeholders that would be interested in having students and professionals in nuclear engineering, yet no one is using them.” Bilbao y León was working at Dominion at the time, and Dominion had a number of strategic partnerships with other universities where some of the Dominion employees had gotten their degrees, including Purdue, Penn State, and the University of Wisconsin at Madison. “That allowed us a one-on-one relationship with these programs,” she said. “We went every year to recruit students for internships or jobs. We really wanted to develop a household name with these universities, but because Dominion is in Virginia, it was difficult to develop that household name [because of the] distance.”

Retention of employees was also an issue, because when these employees began getting married and having kids, Bilbao y León said, they wanted to go back home. “So I went to my boss and said, ‘Why don’t we go to VCU and try to start a nuclear engineering program there?’ Her boss agreed and told her to start the conversation with the university. At first, VCU thought Dominion wanted to use the university to train its own engineers, but once Dominion explained that it already had training programs and simply wanted to create a nuclear education opportunity for VCU students, the university agreed.

Bilbao y León taught the first class in nuclear engineering at VCU in 2007. VCU started with a master’s in mechanical and nuclear engineering, and after a number of undergraduate students expressed interest in taking master’s-level nuclear engineering classes, the department was

able to obtain a curriculum grant from the NRC and began teaching the first class of the department’s undergraduate curriculum in 2009. A Ph.D. program for mechanical and nuclear engineering was established in 2013, and now half of the graduate students enrolled in the department are Ph.D. students.

One of the challenges VCU faced, according to Bilbao y León, was to create a nuclear engineering program that would be accredited for both mechanical and nuclear engineering. “Even though we have enough interest in nuclear, part of the beauty of our program is that the students don’t have to choose,” she said. “They can be mechanical engineers, they can be nuclear engineers. They can customize their paths one way or the other depending on what they want to do later in their careers, but the degree itself meets the criteria for either.”

The second challenge, she said, was recruiting nuclear engineering faculty. The issue goes back to the name recognition that Dominion faced with distant universities. It is more appealing to new faculty to go to a university with an established nuclear program and well-developed faculty to help them build their careers. “If you come to a brand new program, even

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though our infrastructure is growing, it’s not 55 years old,” Bilbao y León said, “so it’s going to take a while before we have the infrastructure of these other programs. As far as faculty support, we have maybe one or two people in each nuclear area, so it’s ‘every man for himself.’ We are really looking for trailblazers.”

VCU does not have a nuclear research reactor, and due to its location in Virginia’s capital, it never will. “We have put together a simulator, which is a very good thing,” Bilbao y León said. “We do have access every once in a while to Dominion simulators, but for us to be able to schedule a class, it takes a lot of coordination.” As a result, she said, VCU has developed relationships with others who do have simulators or reactors. “For example, every summer we take up to 10 students to the Technical University of Dresden. What is cool about this reactor is you don’t need a license to operate it, so basically our students get there, the first day they train us,

and for the next two weeks our students are operating the reactor, all the startups and maneuvers—supervised, of course.”

Enrollment in each tier of the program had been growing since 2009 but has recently dipped, according to Bilbao y León, not because there weren't enough applicants, but “because we decided we can be a little more picky.” She said that they want the Mechanical and Nuclear Engineering Department to be at about 600 students, with about 100 focused on nuclear. Six of the 23 faculty members in the department are focused on nuclear, and there was a faculty position open at the time of the ANS meeting. “Even though we have only six nuclear engineering faculty, we pretty much cover the full spectrum of nuclear research,” she said. “One research area we still need is reactor physics, but hopefully that will be solved by some of the people we have interviewed.” She added that the department needs to become more strategic and to pick a handful of research areas to focus on and gain recognition, rather than trying to do it all. “I definitely would say VCU is a success story. Can we get better? Certainly. But I think we are going in the right direction.”

(For a more detailed article on the 10th anniversary of VCU's nuclear engineering program, see page 38.)

### Nuclear programs at ISU

Mary Lou Dunzik-Gougar, associate professor of nuclear engineering and associate dean of Idaho State University's College of Science and Engineering (and a certified ABET evaluator), spoke next, detailing her experience with ISU's nuclear degree programs.

ISU offers two nuclear-focused programs in two different colleges, the College of Science and Engineering and the College of Technology. “Our Ph.D. program has been around since 1991, and our M.S. program since 1966,” Dunzik-Gougar said of the College of Science and Engineering program, “so we already have



Dunzik-Gougar

a history there. But the bachelor of science program is new. Since I started with ISU in 2004, I helped develop it and watched it grow, and I've seen a lot of changes.” ISU was initially allowed by the state Board of Education to offer only a general engineering degree. Dunzik-Gougar said that the nuclear emphasis was around from the beginning, as an emphasis within the general engineering program.

About 100 undergraduate students and 50 graduate students are enrolled in the nu-

clear program, and it grows through collaborations with other universities. “As soon as the degree program was developed, we had funding from the four [Idaho] universities to support the ‘2 + 2 Program,’” Dunzik-Gougar said, “where students could spend two years at any of the four schools for the basic engineering background, and then come to ISU for the nuclear bachelor's degree. It was a hard sell, and it didn't take off very well. Our first graduate class . . . had five to start out. But students talk, and people go where they know the program is good, so it grew.” She also detailed a new “3 + 2 Program” that the department developed with North Dakota State University (NDSU) that will allow students to graduate in five years with both a bachelor's and a master's degree. “They actually ap-

proached us and said, ‘We don't have nuclear engineering, we don't really have a graduate nuclear program, but we've got this nuclear emphasis in our physics program, and the students really want to go into nuclear,’” she said. “After a lot of talking with entities in both states and both universities, we've got this approved where a student will spend three years in the physics program at NDSU, they'll come to ISU, and in two years, they've got their bachelor of science in physics from NDSU and master of science in nuclear science and engineering from ISU. We hope to have our first participants next year.”

Dunzik-Gougar said that the challenges faced by the College of Science and Engineering include evolving the curriculum, growing the faculty, getting the right areas of emphasis covered, and getting faculty to take accreditation seriously. “They're busy teaching and doing research and just thinking, ‘Ugh, accreditation, that's just a nuisance,’” she said, “and so we had to have some real ‘come to Jesus’ meetings where we said, ‘If you want this program and you want students to come, we have to get accredited, and you have to play this game.’”

Dunzik-Gougar touched on the nuclear program offered through the Energy Systems Technology and Education Center (ESTEC) in ISU's College of Technology. She explained that the ESTEC, established in 2006, grew out of the electronics program, when the university realized that so much electronics work wasn't being done in the United States but was being sent overseas. ESTEC's Nuclear Operations Technology program is a two-year program leading to an associate's degree in applied science. “They use what's called the Nucle-

ar Uniform Curriculum, and they have to have an industrial partner to use it, which is Entergy,” Dunzik-Gougar said. “In order to pass classes, the industry standard is 80 percent. The students receive Radworker II certification after their second semester. They limit the number of students to 16, and they have retention goals of 80 percent, which is incredibly high.” The program is very focused, keeps the students together and closely monitored, and had its first graduates in 2013, she said.

Dunzik-Gougar said that the challenges faced by ESTEC are the uniform curriculum and the industrial partner requirement, as there is not a lot of nuclear industry in the area. She also mentioned the possibility of changing the two-year degree to a four-year program. “They

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base their two-year associate on the fact that utilities require only two years of experience, but INL requires four years, whether that be two years of education and two years in the Navy,” she said. “So now they're thinking maybe we should get a four-year bachelor of applied science, but that's another beast they're looking into.”

### Evolution of NE at UNM

Anil Prinja, professor and chair of the Department of Nuclear Engineering at the University of New Mexico, gave the last of the session's presentations. He provided background on the evolution of UNM's nuclear program, where the graduate program was formed in 1965. The nuclear laboratory, however, was created in 1960 as part of the chemical engineering program. The university acquired its research reactor from the University of California at Berkeley in 1966, and following the downturn in nuclear in the United States during the 1970s, the nuclear and chemical engineering programs merged to form the Department of Chemical and Nuclear Engineering in 1972. After nuclear bounced back, UNM awarded its first undergraduate nuclear engineering degree in 1982, and most recently, in 2014, the departments split into the Department of Nuclear Engineering and the Department of Chemical and Biological Engineering. “With the new program, we also have a new building and

research lab facility that we will move into in January 2018,” Prinja said.

In terms of enrollment, Prinja said that there are typically around 40 to 50 Ph.D. candidates in his department, with about half of the graduates joining a national laboratory following commencement. “We offer bachelor’s, master’s, and Ph.D.s,” he continued. He noted that when the programs split, new degrees did not have to be created. “There have always been degrees in nuclear engineering,” he said.

Prinja also mentioned a new national lab professorship that UNM has undertaken to allow the university to help the labs with retention problems while also maintaining strong relationships between the university and the labs. Another relationship was formed in 2015 when UNM and Sandia National Laboratories signed a memorandum of understanding to create the Academic Strategic Alliance, which, Prinja said, “gives faculty from the main programs—physics, engineering, etc.—to Sandia facilities. It becomes a strong selling point when recruiting new faculty to UNM.”

In terms of challenges, Prinja noted the common thread of name recognition. “There were so many engineering programs that exploded overnight,” he said. “We sat around the table and realized we needed to create a separate nuclear department. We had limited resources, and the dean requested a strategic plan from us for splitting into a separate department. So we did that, outlining the benefits.” Those included boosting the department’s visibility and giving it that sought-after name recognition and identity. “It has a positive influence on research grants if we’re recognizable,” he said. “That’s where the explicit support of the dean is invaluable. If your dean isn’t interested in it, forget it. It won’t happen.” He also noted setbacks stemming from state-level problems, particularly budget cuts to come in 2017 and 2018, and retention issues, mainly due to a loss of senior faculty to retirement. He said, however, that there is hope that more nuclear industry coming to the state will boost the nuclear engineering programs further, similarly to the MOU signed with Sandia in 2015.

Following the presentations, audience members posed questions to the panelists, focusing particularly on how to attract faculty to a new program and how to get the funds to do so. Each member of the panel echoed similar sentiments, with Dunzik-Gougar emphasizing the need for administrative support and Prinja making the point again that funding is a constant battle. But the panel members also reminded the audience that they were there to provide some examples of nuclear programs in various stages of development and to show that progress can, in fact, be made.—*Kaitlin Schuler* **NW**