

Attracting Underrepresented Minorities to PhD Programs - A Retrospective of “A Graduate Traineeship in Cyber Physical Systems” NRT Program

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The National Science Foundation Research Traineeship (NRT) program at the University of Virginia had a very successful first year recruiting U.S. students (a requirement of the NRT grant), especially given it is difficult to attract underrepresented minorities (URM) to most PhD engineering programs. As we reflect on the success, we identified some key areas that may have influenced the high acceptance rates. This paper describes our approach to recruitment as well as potential contributors to the success.

Since it was the first year of the program, we were dependent on the recruiting efforts of five departments for students. From the pool of departmental applications, faculty identified 23 U.S. students who had interest or previous experience or skills in Cyber-Physical Systems. With the goal of programmatic and discipline diversity, each department put forward three nominations. The statistics are as follows:

Pool of Nominations	NRT Fellowship Offers	NRT Fellowships Accepted
23 Total	15 Total	9 Total
15 Female	11 Female	8 Female
8 Male	4 Male	1 Male
6 URM	2 URM	2 URM

As indicated above, the number of females was higher than males initially for our pool, which provided the likelihood of our total number of females would be higher as well. That said, we found it surprising that 73% of the offers made to female students were accepted compared to 25% of offers made to male students. In the hope of identifying any outside motives leading female candidates to accept at such a larger rate compared to the male students, we did a retrospective on how we achieved the success and identified potential reasons for the higher acceptance rate and interest in the program including the (1) institutional and departmental reputation (2) Cyber-Physical Systems as an interdisciplinary research field, and (3) our approach to recruitment of candidates offered fellowships.

Institutional and Departmental Reputation

The University of Virginia and UVA Engineering have established a positive reputation for women and minorities in various areas, including being ranked number one for percentage of women at a US public engineering graduate school at 32%, compared to the national average of 25% [1].

In addition, the NRT program is physically located in the Link Lab, which is a unique graduate space to foster collaboration and engagement with many different disciplines through a 17,000 square foot facility, with over 30 faculty and 200 students representing six degree programs. With this dedicated physical space, UVA Engineering has demonstrated a commitment to the interdisciplinary discipline of Cyber-Physical Systems. Link Lab students represent a broad diversity including gender, race, ethnicity, religion, education and technical expertise. Core to the success of the Link Lab is fostering a climate and culture where diverse perspectives are valued and encouraged so we can advance solutions to complex

cyber-physical problems. Students participating in the NRT program have the opportunity to work alongside researchers from six disciplines and often rely on the different expertise to move projects and research forward. The space also provides students the ability to interact more directly with faculty since faculty and student offices are co-located in the Link Lab. NRT student recruiting events were held in the Link Lab, so prospective students were able to experience this collaborative and diverse environment first hand.

Cyber-Physical Systems as an Interdisciplinary Research Field

The emerging discipline of Cyber-Physical Systems (particularly in Smart Health and Smart Cities) provides a strong context for recruiting a diverse student body, given its engagement with societally impactful systems and applications, which have been shown to help recruiting a diverse study body [3]. The programmatic elements including problem domain, collaborative nature, full well-rounded education and research all contributed to success. In addition, Cyber-Physical Systems is interdisciplinary in nature, which is increasingly of interest to students and in demand by industry and academia. Our students highlighted these benefits in their responses to questions asking what aspect of the program attracted them or they think will be most valuable in their future.

Lauren Bouchard (NRT Student): “The program and curriculum at UVA Engineering allows me to meet experts across many disciplines of engineering, and this is different than most traditional mechanical and aerospace programs.”

Kay Hutchinson (NRT Student): “I also value opportunities to collaborate with people from different backgrounds and specialties while conducting cutting-edge research in autonomous systems, machine learning, and the internet of things. A background in cyber-physical systems topics will be a tremendous influence on my future research projects and career.”

Angelica Sunga (NRT Student): “Cyber-physical systems are a very new area of science that integrates several disciplines. Because new systems raise ethics, standards, and safety questions, there is a need for experts who can speak to these topics. I discovered that a diverse team of professors created the National Science Foundation Research Traineeship Program curriculum. Through this diversity of perspectives, the curriculum equips students not only to create cyber-physical systems, but to answer critical questions about them. The program encourages us, as engineers, to expand our interests and perspectives.”

Approach to Recruiting

During a fall professional development session discussion, students verbally indicated connecting with their faculty advisor was one of the main reasons they selected UVA as their graduate school program [4]. While the area of research being conducted by the faculty was an important fit, the one-on-one interaction between the prospective student and faculty through phone, email and in-person was also a critical element of recruitment success.

We also believe the ability of offering a prestigious NSF Fellowship helped in securing student acceptance of the offer. In addition, many of our top candidates were offered multiple fellowships through or facilitated by UVA, and we believe the ability to “stack fellowships” so students had multiple years of support was a positive factor.

Another critical component of the NRT Program and a tenet of our recruitment success strategy is the cohort model with a professional development focus. Themes of written and verbal communication, leadership, ethics and entrepreneurship are integrated in the new CPS courses as well as the NRT program meetings. Students are also required to identify and attend additional professional development sessions to further increase their expertise in these areas. Some students spoke to how these additional and non-technical skills provide an opportunity for student to gain a valuable skill set for the future. Since this is not traditionally a part of the graduate curriculum, we anticipate it will be a positive recruiting factor in the future.

Milena Milich (NRT Student): “I think the focus on professional development is extremely valuable, especially in technical communications. Undergraduate programs do not address this and being able to communicate about your research is critical to overall success.”

As we move forward, we hope to have another successful recruiting year and expand on the items above as we execute a strategic approach. We plan to leverage the success of our current cohort to continue to increase the number of students in the program and increase the diversity. For our Fall 2020 recruitment efforts, we implemented an outreach plan including attendance at conferences which target traditionally underrepresented minorities in engineering. We also conducted email marketing to various HBCUs and targeted email campaigns to seniors at UVA, student contact lists from other universities, conferences attendee lists, previous REU students, and faculty connections at other universities. We also plan to approach personalized recruitment of students with emphasis on ‘why YOU should be here’ which will include significant faculty outreach and communication.

More information about UVA Engineering’s Cyber-Physical Systems NRT Program can be found on the education page on the Link Lab website: <https://engineering.virginia.edu/link-lab/education>.

This paper is based upon work supported by the National Science Foundation NRT program under Grant No. 1829004.

[1] National Centers for Education Statistics

[2] American Society for Engineering Education’s “Retention and Time to Graduate Survey”.

[3] M. Borrego and Y. Newswander, Characteristics of Successful Cross-disciplinary Engineering Education Collaborations, Journal of Engineering Education, April 2008.

[4] Kelly, Rob. “Communicating with Your Advisor”. NRT Professional Development Communication Session. University of Virginia. October 24, 2019.