Reducing obstacles, improving prospects

A dynamic initiative is shaping the minds of the next generation of engineers. Professors Stephen Zahorian, Doug Summerville and James Pitarresi collectively broach the challenges in attracting the next generation of STEM professionals.

From what context did the S-STEM scholarship programme emerge?

Binghamton University is one of four State University of New York (SUNY) comprehensive university institutions (the others are Stony Brook, Buffalo and Albany). It is the most highly selective campus and is consistently able to attract highly qualified undergraduates. However, many of these students are the first in their families to attend college. In addition, many come from immigrant and/or lower income families. Our motivation was to help these students financially so they could stand a much better chance of finishing their degree. We especially wanted them to join our graduate programme and complete their Master’s degree, using our integrated BS-MS (4+1) programme that enables qualified students to complete both a Bachelor’s and Master’s in five years.

How do you each contribute to the programme?

All three of us are involved with selecting students and mentoring them throughout the duration of the programme. We are instructors for a one credit, one hour per week seminar course. However, as Stephen is the lead instructor for the course he is responsible for overall financial management, the submission of reports and so forth. We work together as a team, along with the students. For example, one semester we had a structured debate (about the pros and cons of fracking for natural gas, a significant issue in our area, due to our proximity to large natural gas deposits) and each team had a faculty member join them in the debate. Another time, each student was assigned to a member of faculty and asked to give a short presentation on one source of energy. Typically, we all attend the weekly seminars, scheduling permitting.

Can scholarship programmes be demographically limiting, or do they promote inclusiveness?

We do our best to select students from a diverse background. We have a good mixture of males and females, Caucasian and Asian students, and majors (computer, electrical and mechanical engineering). Due to the low number of African American students in engineering at the University, we have had only one so far. We have a much higher percentage of females than in our majors overall. Females are a minority in engineering. Scholarship recipients must be citizens or permanent residents and have documented financial need, so we do have to abide by these National Science Foundation (NSF) guidelines.

What are the biggest challenges facing the practice of engineering?

It is well known that the study of engineering not only involves mastering the fundamentals of mathematics, chemistry and physics, but also long hours of study to master the engineering topics germane to the student’s discipline. This work load is intimidating to many prospective students in addition to the perceived (and sometimes real) lack of excitement and appeal about the profession in the minds of prospective students. For example, popular media rarely focuses on engineers in lead roles solving real-world problems; in contrast, we often see doctors, lawyers and nurses. However, the use of mathematics, science and engineering to improve society, by designing creative and innovative new solutions, is inherently appealing to many young people.

Unfortunately, the reality is that the majority of jobs in engineering are somewhat less creative, altruistic and glamorous.

Naturally, all of us in engineering education are working to emphasise the aspects of engineering that drew us to the profession. These include solving challenging technical problems, writing and speaking to convey complex ideas, creativity and entrepreneurship, and using engineering to benefit society. On this last point, for example, we have asked the students to consider and report on various options for energy policy and to study and evaluate the Engineering Grand Challenges as described by the National Academy of Engineering.

How will you build on your success in the years leading to 2020?

One method is to continually seek student input, both informally and formally, on how to best succeed. One lesson we have learned is that it is quite difficult to convince students to remain in school long enough to earn a Master’s. Students with a Bachelor’s in engineering are very much in demand in the workplace and starting salaries are very attractive. Despite our best efforts to convince students that a Master’s degree is in their best interest in the long term, they often choose not to complete further education. As the programme has continued, we have focused more on students who appear likely to complete a Master’s.

Another basic ‘problem’ is that students are so busy in their regular coursework that we have had to scale back the extra enrichment activities for our group of S-STEM students. This was very clear when we attempted to participate in the Solar Decathlon.
Encouraging engineering

A STEM scholarship programme at Binghamton University in the US is increasing access to engineering education. In doing so, it is improving the prospects of students and helping to close the nationwide skills gap.

There are currently almost 11 million unemployed people in America, despite 4 million job vacancies. This large discrepancy is the result of a nationwide skills gap in STEM fields. Globalisation and technological advance mean there is now less demand for low-skilled workers, and a rapidly growing demand for high-skilled workers; allowing unemployment to coexist with high demand for labour in a 'two-speed labour market'. The problem is particularly pressing in engineering; a recent MIT study revealed the damaging impact of the shortage of skilled engineers on innovation in the US. Solving this problem requires more people to study engineering, and stronger links between employers and educators to ensure students pursue careers in the field. Educators must nurture students with an interest in engineering, and make opportunities accessible to a wider range of students.

Professor Stephen Zahorian, Chair of the Department of Electrical and Computer Engineering at Binghamton University in New York, is applying his dual interests in engineering and education to make this possible. His work at the interface of these spheres has led to presentations at conferences of the American Society of Engineering Education and Frontiers in Education. At present, Zahorian is Principal Investigator of the ‘S-STEM’ scholarship programme, alongside co-PIs and Professors James Pitarresi and Doug Summerville. The programme is the result of a five-year, US $600,000 grant awarded by the National Science Foundation (NSF) in July 2010, allowing the Departments of Electrical and Computer Engineering and Mechanical Engineering at Binghamton to offer scholarships of up to $10,000 to nine students per year.

Widening access

The engineering departments at Binghamton have well respected academic programmes and high achieving students. They also have a longstanding history of collaboration, which is leveraged by the scholarship programme through active partnerships with local industry and community colleges. Although the University has a diverse range of successful students, many of these are ‘first generation’ college students who, while they have the necessary qualifications and interest to pursue a graduate degree, are unable to do so for financial reasons. The scholarship programme aims to allow these capable, though financially-disadvantaged, students to complete an integrated five-year Bachelor’s-Master’s programme in computer, electrical or mechanical engineering.

The programme of study follows the recommendations set out in the National Academy of Engineering report, Educating the Engineer of 2020 in order to teach a wide range of skills through Master’s degree programmes. Reflecting the abating domestic engineering talent in the US, and lack of diversity amongst engineering graduates, recruitment efforts have been focused on domestic minorities, women and community college students.

The S-STEM Scholars Seminar Course

The programme supports students in academic success through a range of activities. All students attend a one-hour weekly seminar class focused on generating novel ideas, interacting with industry, and improving writing and speaking skills.

For the spring 2013 seminar, Zahorian and his colleagues chose to focus on a house design project – an exciting venture with demonstrable relevance. The assignment involved the design of affordable and easily maintainable housing suitable for Habitat for Humanity – an organisation which aims to provide housing for those in need. Students investigated a range of efficient house design aspects, ranging from wiring and plumbing, to aspects, ranging from wiring and plumbing, to...
students are encouraged to accept internship opportunities and meet with the S-STEM faculty advisors for guidance in an effort to ensure they have the necessary foundations, and motivation, for a life-long career in engineering.

Alongside the S-STEM Scholars seminar course, students work together on varied projects. In fact, a number of rising seniors in the group are planning to work together on senior design projects, demonstrating the scheme’s capability to build enduring and fruitful partnerships. Throughout the programme, students are encouraged to accept internship opportunities and meet with the S-STEM faculty advisors for guidance in an effort to ensure they have the necessary foundations, and motivation, for a life-long career in engineering.

**DUAL BENEFIT**

The S-STEM scholarship programme will have great benefits, both for its students and for wider society. The direct benefit for recipients is clear; it enables them to pursue a graduate degree. As a result, valuable intellectual output is generated. The carefully structured curriculum will support exceptional engineering graduates with skills in leadership, entrepreneurship and teamwork.

This will be of great benefit to the local economy. As the birthplace of Link Simulation and IBM, the Southern Tier area of New York is fertile ground for technology. However, despite its rich heritage in engineering, the area has experienced an economic downturn in the past two decades. The influx of talented engineering graduates should therefore encourage a technology revival in the region.

Beyond the funding period, it is hoped that graduates will be more likely to consider remaining in the Southern Tier, either working for existing companies or starting their own, due to exposure to local industry throughout the programme. Furthermore, the in-depth evaluation process will contribute to knowledge about best practice in need- and merit-based scholarship programmes.

**ADVANCING THE TECHNOLOGY-BASED ECONOMY**

Of the total number of students in the first three cohorts (28), 10 continued into the 2013-14 scholarship programme. 14 students have so far graduated, 12 of whom have already obtained STEM-related jobs. Because so many entered employment after completing their Bachelor’s, funds remained for a fourth group of students, despite the fact that this was not initially planned.

Zahorian and his colleagues will continue to focus his seminars on the design of sustainable housing and monitor the academic progress of students in order to provide guidance where needed. He also plans to run additional enrichment activities for the students to increase external partnerships, future employment and graduate work.

**SCHOLARSHIP CRITERIA**

The selection of the fourth cohort focused on seniors and first year Master’s students, since only two years of funding remained on the grant.

1. Major in one of the following:
   - Electrical Engineering
   - Computer Engineering
   - Mechanical Engineering
2. Demonstrated financial need
3. Minimum GPA of 3.00
4. Able to graduate with a BS within two years of receipt of scholarship

**FUNDING**

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**STEFEN ZAHORIAN** has been Chair of the Department of Electrical and Computer Engineering at Binghamton University since he joined the faculty as Professor in 2006. Previously, he was Professor and Chair of the Department of Electrical and Computer Engineering at Old Dominion University in Norfolk, Virginia. He received his BSc from the University of Rochester in 1969 and his Master’s and PhD from Syracuse University in 1973 and 1978, respectively; all in Electrical Engineering. He specialises in research involving speech communication, real-time digital signal processing and applications of microprocessors to biomedical engineering.

**JAMES PITARRESI** is Distinguished Teaching Professor and Assistant Provost and Executive Director, Center for Learning and Teaching, at Binghampton University. He received his PhD from the State University of New York, Buffalo, specialising in computational mechanics and structural dynamics. Pitarresi’s current research activities are directed toward a number of interesting computer modelling and experimental measurement problems, many of which arise from the electronics packaging industry and are related to mechanical performance issues of electronic components.

**DOUGLAS SUMMERVILLE** completed his BSc at the Cooper Union for the Advancement of Science and Art, New York, in 1991, Master’s from the State University of New York, Binghamton, in 1994, and PhD in Electrical Engineering three years later, at the same institution. He is interested in hardware security, tamper detection and network security, and is Associate Professor in the Department of Electrical and Computing Engineering at Binghamton University.