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A New Pathway: A Software Engineering Master's Program for Liberal Arts Graduates

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1. INTRODUCTION

Reports such as *Rising Above the Gathering Storm* and its follow-ups by the National Academies highlight an urgency to develop and retain a homegrown workforce in science, technology, engineering, and mathematics (STEM), especially historically underrepresented groups, such as women, due to global competition for science and engineering talent [6][7]. Unfortunately, the percentage of women in computing has dropped dramatically from 30% in the 1990s to 12% today [8]. While research suggests a "leaky pipeline" for women, or women leaving STEM at each stage of their education and career [3] [5], other research finds that women take various "pathways" to enter STEM fields or careers. In other words, while scientists and engineers typically start their careers with enrolling in a bachelor's program in a STEM field in a four-year college, many enter STEM in other ways, especially with the intervention of higher education institutions and federal agencies [4]. Many employed in science and engineering occupations have their highest degree in STEM but not necessarily the bachelor's degree in STEM [8]. Meanwhile, Software Engineering continues to be the No. 1 profession with the most in-demand and well paid jobs worldwide [15][16].

Within this context, we designed and launched an innovative three semester Software Engineering (SwE) Master's Degree program, for academically talented domestic Liberal Arts graduates to increase the number of highly skilled and talented software engineers in the workplace, especially women. The objective of this program is to open a new pathway to Software Engineering for Liberal Arts majors, with the intent of creating a sustainable, replicable, proof-of-concept while increasing the diversity and number of domestic software engineering graduates at Stevens.

2. BACKGROUND

We hypothesize that talented Liberal Arts graduates can and will become successful Software Engineers, through an appropriate Master's of SwE program. Anecdotal evidence exists throughout the industry (and in the author's experience) of extremely successful software engineers and executives who entered STEM after majoring in subjects such as music and philosophy. Also, there is a need for liberal arts in technology, as Steve Jobs pointed out when "he explained the unusual chemistry of Apple that had made it possible for them to Think Different. 'The reason Apple can create products like the iPad is that we've always tried to be at the intersection of technology and liberal arts [13].'" Recent liberal arts graduates also have a higher unemployment and underemployment rate (60%) versus engineering (25%) or math and computing (35%) [1] and as such, are a significant pool of potential talent.

Meanwhile, at Stevens, there has been a shift to fulltime international students in our on-campus SwE program; very few domestic students, other than those supported by their companies, are enrolled in SwE. In 2014-15, ~10% percent of on-campus students were domestic, all of whom were male. Approximately 25% of the overall student enrollments are women.

3. APPROACH AND UNIQUENESS

The problem of low participation of women in computing is extremely troubling to those of us who have had successful computing careers and broke our share of glass ceilings. When trying to understand why the field changed, one thing that became apparent was today's culture of geekdom and "brogrammers" was different from what we had experienced in the 1970s and 1980s [2][5]. We encountered raw sexism and misogyny, but geeks and engineers did not typically see themselves as alpha-males. We also noted that the percentage of computing enrollments of women increases from undergraduate school to graduate school. It may be that as women mature, the negative aspects of the computing cultures have less impact on their decision to enter the field.

Most of the work on improving diversity in STEM and computing concentrates on getting underserved populations into the pipeline early, and then trying to keep them from leaking out. Our approach is different: we are creating a new pathway into a STEM career, and then working to help them succeed within the existing culture (or change it themselves) in graduate school and in their careers.

The first four pathways shown in Figure 1 are the traditional pathways to computing careers. The last pathway, Liberal Arts→MS in SwE, is the one we are adding. This pathway theoretically has the potential to be opened to thousands of students.

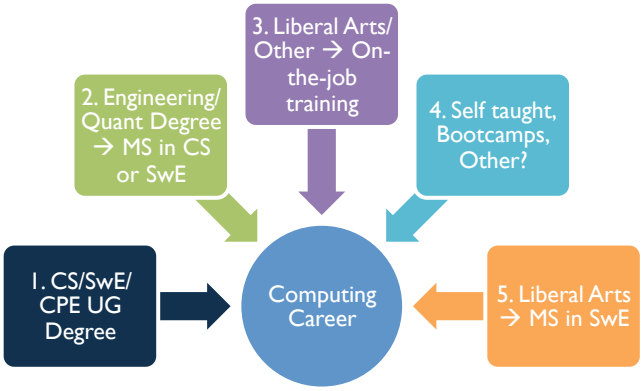

Figure 1: Pathways To Computing Careers

4. OVERVIEW OF PROGRAM

We see our program as having three primary components as shown below.

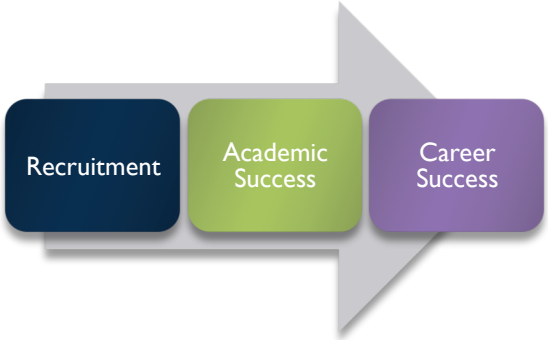

Figure 2: Overview of SwE-LA Program

These components were chosen to address the expected challenges, such as awareness of program, motivation to pursue this career, affordability, ability to thrive in a tech culture, and belief of belonging.

Our recruitment plan consisted of marketing through on-line advertisement, direct email campaigns, newspaper articles, relationships with undergraduate schools and conferences, emphasizing the career opportunity and financial assistance available.

To ensure academic success, we adjusted the curriculum to include additional bridge and studio courses, built a software engineering studio, and assigned mentors for all participants. We are also creating additional relationships with industry for jobs and internships. We plan on having technical seminars on surviving and thriving in the tech industries, specifically to support our women students.

5. PRELIMINARY RESULTS AND CONTRIBUTIONS

5.1 Results:

In the spring of 2015, NSF awarded Stevens with an S-STEM grant for $635K, of which $535K is for scholarships. NSF considers the SwE-LA program to be "very innovative," as well as "high-risk, high-reward."

The program was soft-launched in the fall of 2015, with a phased implementation. By spring 2016, there were 3 students in the program (1 Male, 2 Females), and $15K awarded in scholarships. We have validated our hypothesis that these students can be successful in a SwE MS program, and improved our program for all students.

Relationships with regional undergraduate schools are under development and formalization. One school has proposed a set of preparatory courses for seniors. Focus is currently marketing and curriculum, both of which have had challenges.

The successful marketing to-date has been through personal touch. The on-line advertising and direct email campaigns were unsuccessful. We have revamped the strategy to recruit through career centers in regional undergraduate schools.

The 2014 SwE curriculum assumed either an undergraduate computer science degree or prior professional software experience. For the SwE-LA program, the emphasis on programming increased significantly, and the required courses increased from 6 to 8 plus two programming ramp courses. These changes then became the overall standard curriculum.

In the fall of 2016, the Software Engineering Studio was launched. This 500 square foot studio has become both a hands-on classroom and a central gathering place for all software engineering students.

5.2 Contributions:

We have validated that these non-traditional students can be successful in a Software Engineering MS Program.

We are intent upon opening this new pathway into computing careers, which will be a significant contribution to both women and our national priorities. We have a program, we are learning how improve it, and expect over the next few years to be able to report more findings. We are also hopeful that other schools will create their own versions of this program, and create more opportunities for women and all people to enter computing.

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