Teaching Statement – Eric Keller

One of the most exciting aspects of being a teacher is that you are uniquely positioned to have a significant impact on students' lives. This is a great responsibility and one that I look forward to taking on.

1 Teaching Approach

My philosophy on teaching is built from my own experiences, both as a student (graduate and undergraduate) and as a professional from my years working in industry. Below I discuss my approach as an advisor, as a teacher of undergraduate courses, and as a teacher of graduate courses. Common to each is that building real systems has great value in education. This is especially true today, as there are many platforms available for building real systems without starting from scratch – just in networking there are Emulab, PlanetLab, and VJC (Virtual Junos in the Cloud) as infrastructures academics can use, Click for building packet processing applications, Quagga for experimenting with routing, and NetFPGA for designing networking on FPGAs.

1.1 Advise rather than manage

I believe my responsibility as an advisor is to do just that, advise. I will help students to find and work on their own problems. I will help make connections with other projects by seeing a bigger picture, make contacts with people who have a background that is needed by the student, make contacts to get feedback on the applicability of the student's approach from an industrial perspective, evangelize the student's work, and guide the student in terms of where to look for answers and what tools to use. Of course, many students will not have the ability to work with complete freedom initially since they will not have the skills necessary to perform the research and might not really know what their interests are. I will help students find their interests, team them with students doing something in that area, and if needed give them well defined problems they can work on. Here, my cross-layer approach to research is useful as it allows different students to work together if a problem requires different skills or to approach the same problem from different perspectives. I am currently working closely with five graduate students on a variety of areas. In each case, my role includes clearly defining specific tasks, suggesting related research papers, involving the student in shaping the larger context of the work, and even helping debug code. My goal is to enable these students to take ownership of the research and support them in achieving success.

1.2 Excite undergraduate students and prepare them for successful careers

One of the difficulties undergraduate students face is they get so bogged down learning a lot of new stuff that they forget why they chose to get into computer science or engineering in the first place. I will display my own excitement in order to help the students maintain or rekindle their excitement. Here, this can be reinforced with projects where the students can express their creativity through building complete systems. This is particularly true today where many products that students use have an API (e.g., iPhone, Twitter, Facebook). Not only will the students build something, they'll get to use it. Importantly, this is not restricted to more senior students, as evident by my experience as the teaching assistant for "Computers in our World." This class is for humanities students who want to understand how computing works and how it affects the world they live in. In it, students had several simple programming assignments (e.g., basic web page, web page with some javascript). In interacting with the students on these projects and seeing the end results, I have full confidence that students, even with no background in computers, can make something great.

Beyond building systems for fun, the goal of an education is to develop the skills necessary to enjoy a successful career. The skills necessary in research are very much aligned with skills needed even in non-research careers – being able to be creative, think critically, evaluate an idea, find background needed to solve a problem, and communicate with others. At Princeton, I had the opportunity to work with a few undergraduate students on research projects. As a professor, I would find similar opportunities for undergraduate students to be involved.

1.3 Stimulate research and teach research skills to graduate students

I view graduate-level classes as a good place to invigorate research. For example, I took a class on secure computer architecture which discussed various security issues with a focus on architectural solutions. I tried to incorporate that knowledge into my own research on a future, virtualized Internet where one can lease slices of networking equipment. In such a model, there is an issue of isolating customers and detecting when someone is trying to be malicious, which we explored in a workshop paper. During this time, Amazon EC2 came out and Cloud computing became widely known. I saw that the same issue I was exploring is also applicable to cloud computing, which led to our idea to remove the hypervisor altogether (NoHype). This resulted in a paper at a top conference (ISCA), follow on work at another top conference (CCS), and much follow on work (currently three independent projects by three different groups of students).

In addition to kick-starting research, graduate courses can help students learn how to do research. I will also approach lectures with a goal not just to have students learn about the topic, but to gain some insight into how the authors did research. I gave a guest lecture in the Advanced Networking class where I did just this. Since the topic for this particular class was on my research, I had intimate knowledge on the approach and techniques behind the research and I passed that along. More interestingly though, the discussion about my research and the required readings (which included research that was not mine), went beyond what was in the papers and showed the students thinking the way researchers need to think.

2 Teaching Plans

There are a number of classes I would enjoy teaching and feel qualified to do so.

At the undergraduate level, courses in networking, cyber security, embedded systems, computer architecture, operating systems, logic design, and introductory programming are all classes I could teach. Further, from my extensive background on FPGAs, I could teach or help develop a class that is missing from the curriculum at many schools – reconfigurable computing. This is not just a hardware design topic, but also compliments many areas of computer science and computer engineering in general. I will use my cross-layer research to bridge the gap between the low-level hardware design and the higher-level computer science and computer engineering topics.

At the graduate level, I could teach a number of courses that are commonly found in graduate programs today such as advanced networking, a cyber security seminar, advanced operating systems/distributed systems, and advanced computer architecture. Additionally, once settled, I would look to develop graduate courses with a cross-layer aspect to them that closely matches my research. This includes one on "Dependability of Cloud Services," which would take an end-to-end look at the threats and pain points of the entire infrastructure . It would draw from research on threats in the mobile devices which are commonly used to access cloud services (e.g., leaking private information, mobile malware), attacks on the core Internet which is used connect the user to the service (e.g., denial of service attacks against routers, IP prefix hijacking, bugs in routers), and the infrastructures the cloud services run on (e.g., virtualization vulnerabilities). In each case, we will discuss not only the threats, but the design of systems which would help in defending against these types of attacks. I would also look to develop a second course focused on next generation network architectures. This area is particularly interesting and relevant as we are seeing new technologies emerge (e.g., OpenFlow, network virtualization, software routers/middleboxes), a growing number of distinct networks (e.g., backbone, data center, home, vehicle, wireless edge for media rich smart phones, and the wireless edge for the Internet of things), and an increasing number of properties which have varying levels of importance to different parties (e.g., latency, throughput, mobility, security, reliability, energy).