Should you prepare differently for a non-academic career?

Fan R. K. Chung
Bellcore
Morristown, NJ 07960

By choice or karma, many graduate students in mathematics will eventually have non-teaching careers. Perhaps, then, it is not a bad idea to have some basic preparation in order to broaden one's perspectives as well as to anticipate the new and exciting mathematics out in the "real world". It is equally useful for a teacher or a teacher-to-be to have some understanding about non-academic jobs in order to help the students. Because of the tremendous variety and diversity of non-academic professions, it is almost impossible to paint a general picture. However, it is quite feasible to make some simple preparation along the lines described in the following:

1. Communication skills

I have often heard, "My student can't lecture so he/she should consider an industrial job." This is perhaps the biggest misconception about a non-academic career. Communication skills are even more important outside of classrooms. An industrial researcher interacts with a wide variety of people including engineers, computer scientists, physicists, chemists and business people. The effectiveness of one's work depends on the ability to convey the power and impact of mathematics as well as its beauty and elegance. It is quite possible to explain mathematics in general terms to non-experts. Even a good colloquium talk involves several different levels of depth. Successful communication not only transfers knowledge and insight helpful to others but also brings up good problems, new directions and interesting ideas. Of course, not everyone is gifted with good communication skills. However, preparation and work can help make up the difference.

For foreign students, it is particularly important to try as early as possible to gain proficiency in English, both in speaking and writing. Although it is desirable to preserve and cherish one's own ethnic heritage, it is essential to avoid cultural isolation and to thrive in both worlds (or even to consider the possibility of assimilation) when planning a career in this country. A good measure in this regard is to count the number of English-speaking friends one has, just as the number of academic friends is a very useful indicator of research activities.

2. Depth versus breadth

Graduate study and the dissertation usually focus on very special topics. Typically, in-depth research leads to original and ground-breaking contributions. Although many feel that the antonym of "depth" is "breadth",I would like to argue that breadth can in fact enhance depth. It happens increasingly often that various concepts and tools are borrowed from one area to solve problems in another area. Sometimes, it is hard to tell if a piece of work belongs to, say, topology, geometry, analysis, number theory or algebra. As a combinatorialist, some of my recent work depends on homology theory, which I took in graduate school years ago without knowing it would be of use today. The boundaries between many areas are rapidly vanishing. Above all, almost all branches of mathematics are connected in one way or another. Although it is hard to know which topic will eventually be useful, it is helpful to pay attention to the interconnections and relations among different topics. Especially in non-academic work, there is no textbook to follow and you will never know from which hat the rabbit is going to be pulled.

3. Impact of Mathematics in this changing world

In the past twenty years, we have been in the midst of a technological revolution. The performance of computers has been nearly doubling every year. Vast amounts of information are now being transmitted and processed. While tremendous progress has been made in computer hardware, the development in computer software has comparatively lagged behind. To deal with problems of astronomical size and complexity, clever methods and powerful tools are in great need. Similar to the profound influence of physics in many areas of mathematics, computers will be a major motivating force for mathematics. Conversely, mathematics will have significant impact over the entire spectrum of developments in the next round of the technological revolution, from establishing information infrastructures to software research.

What should a graduate student do to get ready for the interesting and exciting period of mathematics lying ahead of us? In addition to learning as much mathematics as you can, there are areas which deserve special attention. Discrete mathematics, the study of fundamental properties of discrete structures, has now evolved into a rich and dynamic discipline with growing connections to other areas of mathematics and computer science. It would be advantageous for a graduate student (including those majoring in areas of continuous mathematics) to have some exposure to discrete mathematics such as combinatorics, graph theory and number theory, preferably beyond the introductory level. In addition, there are several other courses worth recommending such as geometry with a computational flavor (or with imagination[1]), probability (or combinatorial probabilistic methods), numerical methods or even interdisciplinary courses in algorithms and data structures. However, it is sad to note that very few universities offer many of the courses mentioned above.

Henry Pollak once said," There is no real distinction between pure mathematics and applied mathematics. There is only a difference between good mathematics and uninteresting mathematics." These words have had a lasting influence on my career and I hope they will be helpful to the readers, especially for those who will have non-academic careers.

[1] John Conway, Peter Doyle, and Bill Thurston, Geometry and the Imagination, in "Geometry's Future", Conference Proceedings sponsored by COMAP, Inc., Arlington, MA (1990) pp. 37-80.