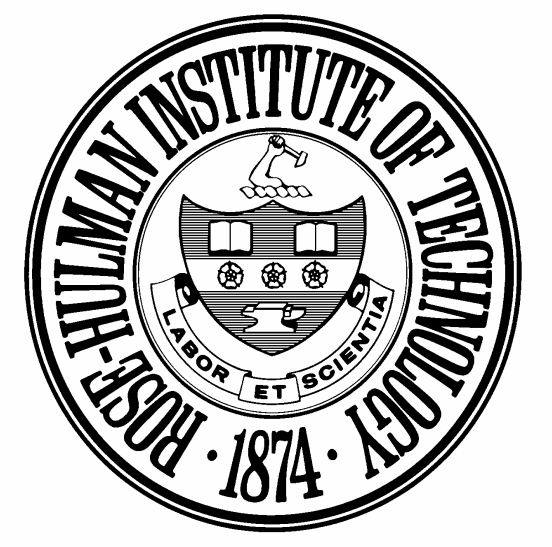
Mathematics Careers
Rose-Hulman and You



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What's a Math degree good for?

"I like math but what do with it after college?" This is the question that I always get asked when I talk to students about studying mathematics at Rose-Hulman. Many of our students get their first interest in science and engineering through mathematics. They start mathematics at an early age and are attracted to the problem and puzzle solving challenge of mathematics. They get great satisfaction with coming up with clever solutions and the neat, logical order of mathematics appeals to them. Like chess it can be an almost mesmerizing intellectual challenge.

Later on, as students get more science under their belts or attend science camps during the summer, their interest in technical fields broadens. The problem solving and intellectual challenges that motivated students earlier takes on "new clothing" in the more hands-on, real world experiences in science, technology and computers. Mathematics is still there; perhaps a bit more in the background, but students still enjoy its problem solving and the neat way things work out. They also begin to understand that math somehow is an important companion to understanding and doing science and technology. Somewhere, students develop a fascination with computers (or at least good skills) and that get thrown into the mix of interests.

Now we are in high school and its time to start thinking about college and beyond. Students are still interested in math but now need an answer to our introductory question: what do your do with a math degree? In the next few pages I hope to give you a start on an answer to that question, pointers to career information and what Rose-Hulman has to offer to the student interested in mathematics.

Mathematically Based Careers. When somebody says "I'm going to be an electrical engineer!", or "I'm going to be a physicist!" we have some idea of what they might do, but who has ever heard of a mathematician, outside of the academic profession. It is not that mathematics doesn't get used every day, but its use is often hidden from view. Complex economic and planning decisions, scientific discoveries that improve our lives, and new technologies and products are often possible only after mathematical or statistical analysis, or computer visualization, simulation, design and implementation based on mathematics. So, often people whose first love is mathematics masquerade as systems analysts, data analysts, operations researchers, engineers, quality control experts, actuaries, statisticians, and financial analysts in business, government and industry. They combine their interest in mathematics with tough real world problems that need talent and creativity to solve. Thus, lots of mathematically based careers exist that math majors will find enjoyable and rewarding. It is just a matter of self-education to find out what they are. To help you find out about this I have included the following in this packet:

The MAA pamphlet We do Math! Careers in the Mathematical Sciences.
The SIAM booklet Careers in Applied Mathematics & Computational Sciences.

Keys to Success in a Mathematics Based Career. SIAM, the Society for Industrial Applications of Mathematics did a long study of non-academic careers looking for the key qualifications of successful mathematicians working in industry and business. Of course these are the things that we would like to learn in college! Paraphrasing their report (see webliography), here is a short list of key skills of successful applied mathematicians:

breadth and depth in mathematics,
interest in and knowledge of other areas,
ability at formulating problems and finding solutions,
knowledge of and experience with computation (computers and software),
communication skills, spoken and written, and
adeptness at working with colleagues - teamwork.

Why is this so? In typical non-academic employment you will work with non-mathematicians, both clients and co-workers, on a problems not stated in mathematical terms. Your job will be to help clients and co-workers figure out what the real problem is using your broad-based knowledge. Next, with co-workers you will develop one or more solutions, almost always with a heavy dose of computing or software development, and then explain the solution to the clients in terms they understand. The process is almost always the same whether you are proposing a pricing policy for a company's insurance plan, doing combustion simulation of a diesel engine, writing software for a hand-held global positioning device, performing statistical reliability analysis of airbag circuit boards or consulting on the computer generated animation of the next "Toy Story" blockbuster movie.

Though the SIAM report dealt mainly with Masters and Ph.D. level mathematicians, the advice applies equally well to students graduating with a bachelor's degree, and students pursuing an academic career. This brings us to the next topic.

Should I go to graduate school? Work in technically based fields is changing so rapidly that you will need to do some post-graduate study that builds upon your undergraduate degree. It may be in the form of a Masters degree or Ph.D., professional accreditation exams such as actuarial exams, or very focused and short workshops at professional conferences. In mathematics, college teaching positions at universities and four year colleges require a Ph.D., and at least a Masters degree to teach at a two year college. In industrial work the highest levels of research are usually held by doctorate holders, though a Master's degree is held by most in research positions in industry. A typical path for baccalaureate graduates who immediately go into the work force is to work at an entry level technical positions and then move on to positions of increasing levels of responsibility and technical depth (often at different organizations) as they gain experience and continue their education. Many employers subsidize graduate and continuing education if it is relevant. The decision whether and when to go to graduate school can be postponed until mid-college but some care is required in course selection, early on.

I like math, but really want to work in another field. Not to worry! Most technical fields automatically require you to take a heavy dose of foundational mathematics in calculus, differential equations, linear algebra and statistics. From there it is only a little extra work to get a minor in mathematics, or, with more work, a second major in mathematics. Science and engineering, especially the most recent "high tech" developments, have sophisticated mathematical and statistical concepts and methods as their foundation. Thus a well chosen set of courses for mathematics minor (or a second major in mathematics) will greatly enhance a student's analytical and computational skills. If you are thinking of going on to graduate school you will be learning many of these advanced methods and so more mathematics background will definitely help.

Why should I consider Rose's program?

I hope I have given you some ideas about careers in mathematics, or if your not going to be a math major, mathematics in your career. Now, why is Rose a good choice?

Top-notch Faculty. First and foremost Rose is a small school that takes it undergraduate teaching mission very seriously. All of our mathematics professors are dedicated and talented teachers, who also find the time to keep on learning professionally. This constant struggle to keep abreast of new developments in mathematics and applications of mathematics will ensure that you are learning the most up to date mathematics and applications of mathematics by the most up to date teaching methods. The mathematics department has played a leading role in Rose gaining its national reputation for teaching innovation, especially in the use of the computer in the classroom.

Good Students. Rose-Hulman has very good students, so that you will be among many other kindred spirits who like mathematics. At college much of the learning comes from interaction with other students, and there is no lack of students with an interest in mathematics at Rose. The only draw back is that it will be harder to convince your friends that you are the "cool math whiz".

Course Variety. Because there are so many students interested in mathematics, you will get a very rich array of upper division mathematics courses, populated by more than just math majors. This diversity of interest and background allows us to give many of the courses an applied flavor to complement the traditional theoretical mathematics courses.

More than Just Math. Above, we spoke of the key skills those mathematicians in non-academic careers need. At Rose-Hulman all of our courses seek to develop one or more of theses skills, not just the mathematics courses. They do so by employing one or more of these learning strategies:

problem solving as a way of learning the concepts,

frequent computer use, especially in mathematics courses, students get used to using computers on the day they step in the door,
group work, both inside and outside of class, and
a multi-week group project with a formal oral presentation and written report.

Our mathematics program requires students to have a good grounding in basic science and to gain further technical depth by taking a set of coordinated courses in another technical discipline. We especially encourage students to take a double major or minor. We have purposely designed the mathematics program to have a large number of electives to enable students to gain this multidisciplinary expertise that is crucial to the non-academic career. For students with advanced placements it is not unusual for students to do a double major and a minor as well.

Double Majors and Minors. We are especially proud of our double majors program. In fact, as many or more students are taking a second major in mathematics as taking mathematics as their first major. Double majors can be easily done with mathematics and any science: computer science, physics, chemistry, and economics. The Computer Science-Mathematics double major (or it reverse) is the most popular double major on campus. For students interested in going into business or the insurance industry we recommend a Mathematics and Economics double major (or the reverse). The curricula of engineering students are a little less flexible than science programs because of accrediting agency standards. Thus while a double major in engineering and mathematics can be done if there are advanced placements, I often recommend that students take a minor in mathematics (four additional upper division courses). The four courses can be tailored to the students program and provide that extra analytical depth and modeling experience.

What about Graduate School? Roughly half of our mathematics majors go on to graduate school. We encourage these students to use their electives to take more mathematics, especially the theoretical courses that will prepare them well for graduate school. Our grad school bound students have all gone on to well-regarded schools and are doing well. A good preparation for graduate school is an undergraduate research project, complete with formal presentation and formal Technical Report. For these projects, we draw upon our fifteen year experience with Research Experience for Undergraduate Program funded by the National Science Foundation.

Advanced Placement. Rose-Hulman, especially the Mathematics department, is generous with advanced placements. Our goal is start students off in a mathematics course that challenges them and doesn't repeat material that they have mastered. Though we do not require calculus for entrance to RHIT, almost half of our entering class skips the first quarter of calculus, and about 10% of freshmen skip the first year of mathematics entirely, and start at sophomore level mathematics. Our Fast Track program is especially effective in giving students a boost. Through our intensive five-week summer program, students translate a year of high school calculus into an entire year of college calculus credit. It is the most highly regarded program on campus. Though the occasional student

takes advantage of their advanced placements to graduate a little early the vast majority use the freed up time to take a minor or take a certificate program.

The Rose Extras. At Rose we have several co-curricular activities of which we are very proud and which we believe adds an extra dimension to a student's mathematics education. The first is our participation in mathematical competitions. Every year we participate in one local competition, two regional competitions, and two national competitions. We also host a high school mathematics contest to 500 students at Rose and an additional 1500 students at satellite sites. We are proud of our students' excellent achievements (we have won top honors twice in one national competition) but are even more proud of the number of students who participate in all these activities. The total number of students who participate in these contests is almost the size of the football team (and has a better record). We in the Mathematics like to say that we are a Division III school at athletics but Division I in Mathematics.

We believe it is very important for students to work on challenging projects and make formal oral and written presentations of their work. Thanks to alumni donations for this purpose, we are able to help students to defray the cost of these trips to present their work. For students who are a little timid about going off campus to present we have our own nationally known Undergraduate Mathematics Conference. Finally we encourage students to write up these reports in our Mathematical Science Technical Report Series.

I hope this helps. You can get more details on career opportunities and the special mathematics programs at Rose in the Webliography.

Bibliography

1 *101 Careers in Mathematics*, Andrew Sterrett, Editor, Mathematical Association of America.

2 *She does Math!, Real life problems from Women on the Job*, Marla Parka, Editor, Mathematical Association of America.

Webliography

Careers in Mathematics

1. *SIAM Report on Mathematics in industry:* http://www.siam.org/mii/miihome.htm
2. *SIAM Career Information Page:* http://www.siam.org/career.htm
3. *MAA Undergraduate Career Page: http://www.maa.org/students/career.html*
4. *MAA Career Profiles Page: http://www.maa.org/careers/*
5. *AMS Undergraduate Page: http://www.ams.org/employment/undergrad.html*
6. *American Statistical Association Careers Page: http://www.amstat.org/careers/*
7. *INFORMS Career Page: http://www.anderson.ucla.edu/informs/career/*

Undergraduate Mathematics Web Pages

8. *Math Archives Undergraduates' Page:* http://archives.math.utk.edu/undergraduates.html
9. *The MAA Student's Page:* http://www.maa.org/ (go to students)
10. *The SIAM Undergraduate Math Page:* http://www.siam.org/students/index.cfm/

Rose-Hulman Web Pages (all can be reached from the mathematics page)

11. *Rose-Hulman Institute of Technology:* http://www.rose-hulman.edu
12. *Rose-Hulman Mathematics:* http://www.rose-hulman.edu/math/
13. *Fast Track Calculus:* http://www.rose-hulman.edu/maFTC/
14. *Rose-Hulman Undergraduate Mathematics Conference:* http://www.rose-hulman.edu/mathconf/
15. *Rose-Hulman NSF-REU:* http://www.rose-hulman.edu/mathREU/
16. *Mathematics Competitions and Problems:* http://www.rose-hulman.edu/math/newsevents/competitions.php
17. *RHIT Student Research Page: http://www.rose-hulman.edu/math/researchpubs/studentresearch.php*