

## Careers that start out by taking mathematics – Craig L. Zirbel – [zirbel@bgsu.edu](mailto:zirbel@bgsu.edu)

We all know that you can be a math teacher, and the US certainly needs more good math teachers at all levels!

- Middle school teacher (roughly a math minor, second minor and education major)
- High school / Integrated math (roughly a math major and an education double major)
- District math coordinator (math major + master's in curriculum and development)
- Community college (math major + master's degree in mathematics)
- Small college professor (math major + master's in mathematics + Ph.D. in mathematics)
- University professor (math major + master's + Ph.D. + continued strong research program)

### Graduate degrees in mathematics

- Generally, you pay no tuition, you get a stipend of \$12,000 or more, student loans are deferred, and you teach 1000-level math (which gives you valuable teaching and public speaking experience)
- Is there anything left to do in math research? Yes! Some things that have been completed recently: Fermat's last theorem (1993), the sphere-packing conjecture (1997), the Poincaré conjecture (2003)
- Some things are easy to state but are apparently hard to prove: twin primes,  $3x+1$ , normality of  $\pi$
- Other problems are harder, but have \$1 million prizes if solved, see [www.claymath.org/millennium/](http://www.claymath.org/millennium/)
- There are many other good problems to work on, probably more than ever before, coming from pure mathematics and from applied mathematics
- You can get a Ph.D. in Mathematics Education, do research on how students learn mathematics, and teach at a College or University. Something like 70% of math education jobs went unfilled in 2009!!!

### Specific career paths for someone with a mathematics major

- Actuarial science (roughly a math major plus a business minor, then several more exams to pass in the first decade of your career). Work for an insurance company setting prices (premiums) for insurance. They are looking for you, and you know where to apply. \$46,000/\$76,000/\$120,000 after 1/5/10 years. Actuaries are needed more and more by other industries as well. Work for a financial services company that manages pensions or investments. Work in long-term health care or for a government agency.
- Statistics (roughly the same as a math major). Many companies and government agencies need to make decisions in the face of uncertainty. They don't know what will happen in the future, and they also have a hard time interpreting the data they have from past experience. Your opportunities are better in statistics the more degrees you earn, but you can start with a bachelor's degree. Many companies specifically hire statisticians at the Bachelor's, Master's, or Ph.D. level.
- The Wall Street Journal, January 6, 2009 wrote about a [careercast.com](http://careercast.com) study that ranked Mathematician, Actuary, and Statistician as the #1, #2, and #3 jobs in the country. You can't beat that! In 2011, they were #2, #3, #4.
- Government is the largest single employer of mathematicians; the finance/insurance industry is second
- National Security Agency – cryptography, keeping secrets, decoding the other side's codes.
- The US Census Bureau hires many statisticians to analyze census data. It keeps them busy for 10 years!
- See <http://www.ams.org/careers/> for information about math careers
- See <http://www.ams.org/profession/career-info/early-careers/early-careers> for biographies of people who found very interesting careers after getting degrees in mathematics.

### Many large companies hire mathematicians to work on a team

- GM and other companies design cars. They need them to be strong so they protect the occupants in case of a crash. But they also need them to be light weight, so they get good gas mileage. They don't build too many cars and crash them into brick walls to test their strength. Before it ever gets to that stage, they design cars on a computer and simulate the crashes. The computer programs that do this need an immense amount of knowledge built into them. They need input from mechanical engineers, who know about the strength of materials and how they bend and fail. There are complicated equations for this from physics, but these equations need to be understood in detail, and that is what a mathematician can do. The team needs to solve these equations numerically (not exactly!) on a computer. Mathematicians can help with designing algorithms to solve these equations, while computer scientists are good at making the programs run fast. Everyone plays a part.
- Boeing designs airplanes, but doesn't build models and test them in a wind tunnel, that's too slow. They're designed on computers. But it's not just a matter of drawing an awesome-looking airplane. It needs to be designed to be aerodynamic and to have enough lift to be able to carry passengers and cargo.

- Oil companies use a variety of techniques to guess where the oil is, all of which are fairly sophisticated and mathematical. They don't just "pump oil out". They inject a fluid like water to push the oil through the reservoir toward the wells. Modeling the flow of the water and oil is a hard mathematical problem.
- Anywhere that you see technical limitations, mathematicians or highly mathematical engineers or other scientists are working. Yes, we need mathematicians to work on green and sustainable energy projects!

You can get involved with research groups at BGSU while you're an undergraduate!

- We had an undergraduate computer science major, math minor work with myself and a biochemist for over two years. She was able to quit her campus job because there was money to pay her to do research work. She wrote code in Java that solved a computational problem in aligning RNA sequences from different organisms. In the Fall of 2008 she started a Ph.D. program in Bioinformatics at the University of Colorado, Boulder. She is the only one there without a Biochemistry background, but they were thrilled to have her in the program, because they rarely get students who know how to program well and who have such a strong math background.

Many engineers are practically mathematicians ...

- ... which means it's not that hard for a mathematician to become an engineer. Take some physics, take some chemistry, and talk with an engineering graduate program early in your college years. Engineering programs are happy to have strong mathematics majors, because it's not so hard to teach engineering, what they need to know is that you'll be able to do the math all the way through.

Mathematics as a second major or a minor

- Whatever your major in college, keep taking math courses. It will only do you good. If you get a minor in mathematics or statistics, or even a second major in mathematics, fine. Just keep taking math!
- In many fields, the farther you progress, the more important mathematics becomes. This is true in Biology, Economics, Psychology, etc. Don't top out in your field because you don't know enough mathematics!
- Some graduate programs such as engineering, economics, and even sociology and neuroscience are open to applicants with an undergraduate degree in mathematics, but less background in their particular area. Mathematics used to be a common pre-med major. Why? Because they know these students can pick up the details of their area, and will not be stopped by the level of mathematics in their program.
- Mathematics teaches you how to think, how to analyze, how to simplify, how to focus on the essential facts and leave aside what doesn't matter so much. This is useful in every field.

Banks and other financial institutions need people who know math

- Banks, mortgage companies, financial services companies can be found everywhere.
- They don't necessarily advertise that they are looking for mathematics majors, but they do quantitative work, and if that is your strength, you will be a very good employee for them.
- Improve your employability by learning Excel, some computer programming, and by taking courses in economics and accounting.
- Consider taking a course like Math 425, Theory of Interest. Learn about the present value of money: What would your bank prefer to have, \$100,000 today, or payments of \$12,000 a year over the next 10 years?

Mathematics is everywhere, but hides itself well.

- Encryption in business transactions – ever notice the padlock on a browser when you visit [https://... ?](https://...)
- Data compression in cell phones and the internet, jpg pictures, digital TV, music (mp3), movies (DVD)
- Statistics in health studies – did you hear about the multi-billion dollar Vioxx settlement?
- Engineering – designing cars, airplanes, and lots of simpler devices on computers
- Fighting crime – the show NUMB3RS has real cases, though it exaggerates how quickly a mathematician can work, or how accurate the predictions will be.

Math classes to take at BGSU

- Math 1310, 2320, 2330 – The standard calculus sequence. Good for the major or the minor.
- Math 2470 – Introduction to probability and statistics, the first course in the Statistics minor.
- Math 3320 – Linear algebra. Systems of equations and matrices. Amazingly useful for applied mathematics and as a foundation for all of pure mathematics.
- Math 3220 – Discrete math. Logic, set theory, graph theory, counting.
- Math 3370 – Differential equations. How real-world systems change over time.