

## Careers

### Fields of Study: All

What can you do with a math degree other than teaching? – A general impression held by the majority of us. In fact, a more accurate question to ask should be “what can’t you do with a math degree?” Actually, the study of mathematics extends far beyond just number crunching and doing fast mental arithmetic in grocery stores. It turns out that studying mathematics prepares one for nearly and reasonably any career imaginable. In general, companies believe that studying mathematics develops analytical skills and the ability to work in a problem-solving environment. These are the skills and experience that are essential assets to one’s success in the work place. Precisely, mathematics is often the quintessential element to fluently communicate with people of various backgrounds. It is the ability to efficiently process a manifold of information and deliver the technical details to a general audience that makes mathematicians valuable. Having a mathematics background not only helps people broadening their pool of career options, it also helps to land you the best jobs known to people.

According to an article published in the Wall Street Journal on January 26, 2009, mathematician is considered to be the best job in all occupations in the U.S. The ranking was determined based on five criteria inherent to every job: environment, income, employment outlook, physical demands, and stress. In fact, five out of the six “Best Jobs” in terms of low stress, high compensation, autonomy, and hiring demand in the “Job Related Almanac” by Les Krantz are all math related – 1. Mathematician, 2. Actuary, 3. Statistician, 4. Biologist, 5. Software Engineer and 6. Computer Systems Analyst. In the rest of this article, we will provide a collection of possible career opportunities that are most appropriate for someone with a mathematics background; and a list of resources on how to find a job with different levels of academic degrees. The lists are, by no means, exhaustive and should only be used as a reference.

Why is mathematics a required subject in school curricula at all levels? Equivalently, why is mathematics so essential for the proper functioning of everyday tasks in society? Why do most people who excel in their field of work credit their success to their formal training in mathematics? One possible reason is that a proper training in mathematics provides people with abilities to think and solve problems critically in novel settings.

A website sponsored by the Department of Mathematics at Brigham Young University provides a list of possible career options for someone with a background in mathematics. Some of the more common professions include actuary, architect, chemical engineer, college professor, computer scientist, cryptanalyst, economist, mechanical engineer, quantitative financial market analyst, statistician while some less well-known ones include air traffic controller, animator, astronaut, epidemiologist, geologist, hydrologist, lawyer, market research analyst, composer, physician, technical writer, and urban planner. Certainly, no fixed set of mathematics curriculum will prepare one for all the jobs listed here. What is consistent across the board is the ability to solve problems analytically and critically.

Did you know that the famous San Antonio Spurs basketball hall of famer David Robinson had a B.S. in mathematics from the United States Naval Academy? And even Michael Jordan toyed with the idea of being a math major in his early college years. It is perhaps not surprising that one of the world’s most influential bankers and financiers, J. P. Morgan, majored in

mathematics, but who would think that mathematics can also find its way to the entertainment industry. For example, American actress Danica McKellar who had a leading role in a television comedy-drama *The Wonder Years* is a well-known mathematics author and education advocate. A popular television drama *Numb3rs* on CBS features a mathematician who helps his brother in the FBI to solve crimes with his mathematical genius. A few popular movies that successfully portrait mathematicians in the society include *Good Will Hunting* (1997), *A Beautiful Mind* (2001), and *Proof* (2005). More career choices can be found under further readings.

Although it is seemingly impossible to categorize different branches of mathematics due to its extensive uses in every operation of the society, we will make a crude attempt to provide a list of career options available for someone who studies under some common branches of mathematics, particularly, the areas of Applied Mathematics, Actuarial Mathematics, Financial Mathematics, and other emerging fields.

Applied Mathematics. Applied mathematicians often solve problems originated in physics, chemistry, geology, biology, or various disciplines of engineering. Mathematics is used to model physical phenomena, to answer questions derived from observations, to learn characteristics of large quantities, to make prediction and improvements for future events, etc. A representative mathematical training includes course works in numerical analysis and methods, basic understanding of computer programming and familiarity of a few computer languages, applied and experimental statistics and probability theory, and preferably a few courses in the field of interest. Often time, a typical applied or computational math problem is interdisciplinary in nature and derived from realistic demands in industry. People who wish to gain a general sense of what these types of problem entail are encouraged to attend math-in-industry workshops that are available in Europe and some parts of United States and Asia. Mathematics in Industry and International Study Groups maintains a website that provides updated information for future study groups and meetings.

For example, someone with a mathematical training may be asked to solve problems such as “How can you mathematically model the spread of a forest fire depending on weather, ground cover, and type of trees?” and “How can an airline use smarter scheduling to reduce costs of aircraft parking and engine maintenance?” If you are interested in answering these types of questions, then you might be happy to know that agencies and companies like National Oceanic and Atmospheric Administration (NOAA), American Airlines, and IBM Research will be happy to have you. Society for Industrial and Applied Mathematics (SIAM) maintains a list of example organizations, corporations, and research institutions that hire mathematicians and computational scientists with an applied mathematics training. A few items from the list are given here for convenience.

- Aerospace and transportation equipment manufacturers such as The Aerospace Corporation; Boeing; Ford Motor Co.; General Motors; Lockheed Martin; and United Technologies.
- Chemical and pharmaceutical manufacturers such as DuPont; GlaxoSmithKline; Kodak; Merck & Co., Inc.; Pfizer; and Wyeth.
- Communications service providers such as Clear Channel Communications; Qwest Communications; and Verizon.

- Computer service and software firms such as Adobe; Google, Inc.; The MathWorks, Inc.; Microsoft Research; MSC Software Corporation; Palo Alto Research Center; and Yahoo Research.
- Electronics and computer manufacturers such as Bell Laboratories, Alcatel-Lucent; Hewlett-Packard; Honeywell; IBM Corporation; Motorola; Philips Research; and SGI.
- Energy systems firms such as Lockheed-Martin Energy Research Corporation and the Schatz Energy Research Center (SERC).
- Engineering research organizations such as AT&T Laboratories – Research; Exxon Research and Engineering; NEC Laboratories America, Inc.
- Federally funded contractors such as the Mitre Corporation and RAND.
- International government agencies such as the Defense Science and Technology Organization, DSTO (Australia); French Atomic Energy Commission, CEA/DAM; and National Research Council Canada.
- Medical device companies such as Baxter Healthcare; Boston Scientific; and Medtronic.
- U.S. government agencies such as the Institute for Defense Analyses (IDA); NASA’s Institute for Computer Applications in Science and Engineering; National Institute of Standards and Technology (NIST); National Security Agency (DIRSNA); Naval Surface Warfare Center, Dahlgren Division; Supercomputing Research Center; and the U.S. Department of Energy.
- U.S. government labs and research offices such as the Air Force Office of Scientific Research; Lawrence Berkeley National Laboratory; Los Alamos National Laboratory; Oak Ridge National Laboratory; Pacific Northwest National Laboratory; and Sandia National Laboratories.
- Producers of petroleum and petroleum products such as Amoco; Exxon Research and Engineering; and Petróleo Brasileiro S/A, Petrobras.

Actuarial Mathematics. An actuary is a risk management professional who helps to design insurance plans, including recommending premium rates and making sure companies are designating enough funds to pay out on claims. Actuaries may also help create new investment tools for financial institutions. The main type of math an actuary uses on a daily basis is applied statistics. This involves arithmetic, basic algebra and practical applications, such as using numbers and math to generate tables and graphs. It is also advised for actuaries to have a general understanding of business, economics, and corporate finance, all of which have mathematical components. Most actuaries have at least a 4-year degree in mathematics, business, economics, statistics, or in some cases, a specific degree in actuarial science. As computer modeling replaces traditional graphs and tables, computer and programming skills have become increasingly more important as well. The last step to becoming a licensed actuary is to get certified by passing a series of exams sponsored by either the Society of Actuaries or the Casualty Actuarial Society. The list of possible job choices for someone with an actuarial background is relatively smaller compared to that of the applied mathematicians. These are:

- Consulting firms such as Daniel H. Wagner Associates, Deloitte Touche Tohmatsu, Ernst & Young, Hewitt, and McKinsey & Company, and KPMG.
- Banks or related financial institutions such as AIG, ING, Capital Management, Chase Manhattan Bank, CitiGroup, Fidelity Investments, Goldman Sachs & Co, HSBC, JP Morgan Securities, Lehman Brothers, Mercer Investment Consulting, Merrill Lynch, Morgan Stanley & Co, Standard and Poor's, TD Ameritrade, Wachovia Securities.
- Brokers such as Acordia, Benfield, Cooper Gay, Heath Lambert, HLF Group, March & McLennan, and Willis Group.
- Actuarial software development companies such as Actuarial Resources Corporation (ARCVAl, HealthVAL, STAR, UltraVAL, CARVM), BLAZE SSI Corp., EMB America LLC, Integrated Actuarial Services (Total Solution, RAAPID), TAG, WySTAR Global Retirement Solutions (DBVAL, DCVAL, OPEVS).
- Miscellaneous jobs in big companies and government agencies such as ACTEX Publications, Casualty Actuarial Society, Coca Cola, Ford Motor Company, International Actuarial Association, National Association of Insurance Commissioners, and Society of Actuaries.
- Insurance companies including property and liability insurance, life and health insurance such as AFLAC, AAA of CA, Allstate, Blue Cross and Blue Shield, Safeco, Sun Life, Universal Care, and Wellpoint.

Financial Mathematics. Financial mathematics is the development of mathematical tools and computational models used in the financial industry and on Wall Street. People in this profession are referred to as quantitative analysts, or ``quants''. As new quantitative techniques have transformed the financial industry, banks, insurance companies, investment and securities firms, energy companies and utilities, multinationals, government regulatory institutions, and other industries have come to rely on applied mathematics and computational science. Sophisticated math models and the computational methods and skills needed to implement them are used to support investment decisions, to develop and price new securities, to manage risk, and for portfolio selection, management, and optimization. For example, modern hedge funds depend on these sophisticated techniques as do pricing of bonds and commodity futures. Typically, someone who is interested in working in financial service and investment firms such Citibank, Moody's Corporation, Morgan Stanley, and Prudential will need to have a solid background in mathematical modeling, numerical and computational mathematics, applied statistics, business, economics, and finance.

#### Emerging Fields.

- Biomathematics and Bioinformatics. This emerging field is a sort of Computer Science/Mathematics/Biology hybrid that integrates mathematics and computer technology in the study of biological sciences. Broadly speaking, Bioinformatics is the recording, annotation, storage, analysis, and searching/retrieval of nucleic acid sequence (genes, RNAs, and DNAs), protein sequence and structural information. Mathematicians in this area contribute to the development of new algorithms with which to detect patterns

and assess relationships among members of large data sets and the analysis and interpretation of various types of data. Possible companies to work for are

- Computer Visions and Computer Graphics. Mathematicians in the field of computer vision work on developing theoretical machine learning algorithms to extract meaningful information from images. The images take on various forms such as waveforms from voice recorders or 3-dimensional images from a magnetic resonance imaging (MRI) device. Its example applications include
  - Artificial intelligence and controlling processes (e.g., industrial robots and autonomous vehicles)
  - Pattern recognition and verification (e.g., public surveillance and biometric identification)
  - Modeling and processing (e.g., medical image analysis and terrain modeling)
  - Communication (e.g., brain-computer Interface for people with disability)

On the other hand, mathematicians in the field of computer graphics develop ways to represent and manipulate image data to be used by computers. The most well-known applications under this category are the video-game and computer animation industry where various transformation matrices and interpolation techniques are used to create smooth and believable subjects in successive frames. Companies such as Pixar and Dreamworks hire mathematicians in their research division to come up with innovative ways to enhance the visual effects that are more aligned to reality. Other companies that hire mathematicians with background in computer vision and graphics include Siemens, Hewlett-Packard (HP), Honeywell, FlashFoto, GeoEye, Nokia, Microsoft, Apple Inc., Amazon.com, Google, etc.

- Operations Research. This is a highly interdisciplinary branch of applied mathematics that uses methods such as mathematical modeling and optimization to solve problems that require a complex decision-making process. Mathematical areas such as game theory and graph theory have become useful tools in attacking problems under the umbrella of operations research (OR). Example disciplines that uses OR are financial engineering, environmental engineering, manufacturing and service sciences, policy making and public sector work, revenue management, and transportation. Almost all companies hire some sort of operations research analysts to use mathematics and computers to develop software and other tools that managers can use to make decisions such as how many people to hire and retain in order to maximize productivity and minimize costs.

It is worth reemphasizing that having a mathematics degree or a math-related degree increases one's chance of securing a position in nearly any company. And even areas that are traditionally viewed as pure mathematics such as combinatorics, number theory, topology, algebraic and differential geometry, analysis, and algebra often turn out to have real-world applications. For example, number theory in cryptography, Fourier analysis in speech recognition, and differential geometry in face recognition. Some more career choices that were not mentioned in the lists above are

- Nonprofit organizations such as the American Institute of Mathematics (AIM) and SIAM.
- Publishers and online products such as Birkhauser, Springer, and Elsevier Science.
- University-based research organizations such as the Institute for Advanced Study; the Institute for Mathematics and Its Applications (IMA); and the Mathematical Sciences Research Institute (MSRI).
- Government agencies such as National Security Agency (NSA), U.S. Department of Defense (DoD).
- Academic Institutions. To teach at the high school level, one would need a Bachelor's degree in mathematics (in various options) and a teaching credential; to teach at the community college level, one would need a Master of Science or Master of Art degree in mathematics; to teach at the college level, one would need a Ph.D. in either mathematics, mathematics education, applied mathematics, or statistics.

### Online Mathematics Jobs Listings

- The American Mathematical Society (AMS) has an extensive set of resources to help someone in the market for academic positions and is the premier source for information on careers in mathematics. This includes a list of job postings organized by country and state. It has neat features such as an email service that notifies you all new job listings and an online storage of curriculum vitae (academic resume) and transcripts, etc, that can be used repeatedly for different applications. In addition, it allows one to register for the job fairs at the annual AMS meetings and graduate programs for students.
- The Math-Jobs website lists international and national job openings for mathematicians in both industry and academics.
- The Mathematical Association of America (MAA) has a comprehensive set of resources for students, faculties, professional mathematicians, and all who are interested in the mathematical sciences. In particular, MAA Math Classifieds helps people to find career in the diverse field of mathematics.
- Chronicle of Higher Education has academic and non-academic job advertisement. Use the searchable index to find mathematics jobs.
- Mathematical Sciences Career Information by AMS-SIAM has a lot of information on non-academic jobs, including profiles of mathematicians in industry, job search tips, and pointers to many online job posting services.

SEE ALSO: Accounting; Mathematics, Applied; Problem Solving in Society; Professional Associations.

FURTHER READINGS:

Sterrett, Andrew. 101 Careers in Mathematics. Washington D.C.: The Mathematical Association of America, 1996.

Jackson, Allyn. Careers that Count. Association for Women in Mathematics. Maryland. 1994.

Lambert, Stephen & DeCotis, Ruth J. Great Jobs for Math Majors. VGM Career Horizons. Chicago, Illinois. 1999.

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