This science isn't just for mathematicians anymore

Mathematics resources on the Internet

by Timothy E. McMahon

Math is cool . . . and it has been for a long time. Throughout the ages, mathematicians have made earth-moving discoveries and contributed to our species ever-present drive into the technological future.

Think of this past half-century alone. During the 1950s, Cathleen Morawetz wrote influential papers that helped revolutionize airplane wing design, leading to smoother flight. In 1998, she was awarded the National Medal of Science, America's highest scientific honor, for her contributions to science.

In 1994, Andrew Wiles's long and solitary work led to his much celebrated proof of Fermat's Last Theorem.

And on a more whimsical note, a team from Macalester College won second prize at the Breckenridge International Snow Sculpture Competition this year. Their entry? You guessed it—a model of the Enneper Surface, a minimal surface with tremendous symmetry and huge overhangs.[1]

While there have been some highly visible achievements in mathematics, it's only over the past five or six years that mathematics has emerged into the spotlight of popular culture. Books like *The Man Who Loved Only Numbers*, which highlights the life of prolific mathematician Paul Erdös, or the controversial work *The Bible Code*—whose thesis is that through mathematical analysis, coded prophesy can be drawn from the Hebrew Bible—are flying off bookshelves everywhere. *Good Will Hunting* drew huge crowds to the theaters to see a fictional mathematical genius from the wrong side of the tracks in South Boston grapple with his inner demons. Some of these works are not without controversy, but this only serves to get people talking about mathematics.

An increasing number of reporters are also including mathematics in their coverage of scientific advancement. In his *New York Times* column, Paul Lewis pointed to an article that appeared in *The Notices of the American Mathematical Society* highlighting "What's New in Mathematics."

This section of the American Mathematical Society (AMS) Web site is designed as a public relations effort to help reporters find out about stories in mathematics. The AMS's What's New in Mathematics Web offering strongly illustrates the Web's importance as a vehicle for the transfer of technical and scientific materials in a language that is right for the nontechnical population.

The Web's growth has allowed mathematics to percolate up to the desktop of anyone willing to take a few minutes to look for the topic. Web sites, reviewing literature databases, preprint servers, journals, and a host of other resources are but a click or two away.

About the author

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This article will point to a select set of resources in the hopes that by doing so, the reader's appetite will be stimulated enough to gather additional resources and to pass these on to friends and colleagues. In some cases throughout this article, resource descriptions provided by the content creators have been used.

Metasites

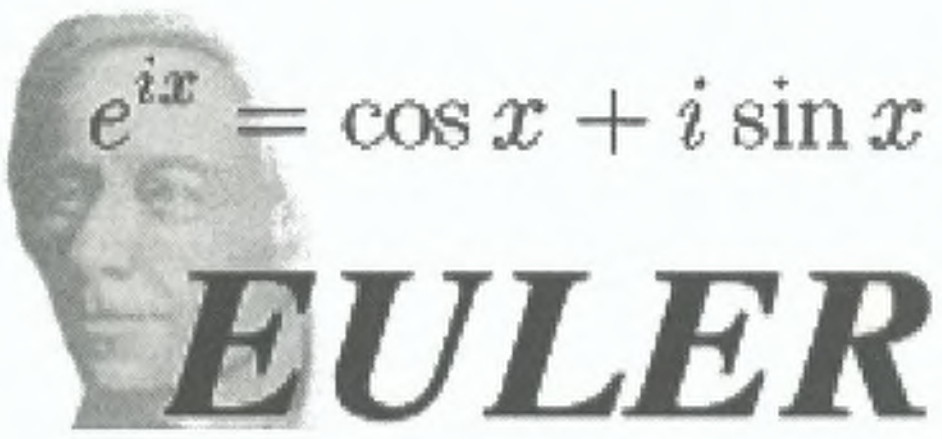
• **Open Directory Project—Mathematics.** The Open Directory Project's goal is to produce the most comprehensive directory of the Web, by relying on a vast army of volunteer editors. The mathematics index is similar to the Yahoo! site in its presentation of a rich set of links to Internet resources. *Access*: http://directory.netscape.com/Science/Math.

• **Yahoo! Science: Mathematics.** With half a million sites divided into more than 25,000 categories, Yahoo! is both browsable and searchable—a good place to find links to relevant resources. *Access*: http://dir.yahoo.com/Science/Mathematics/.

• **Galaxy.** Launched in January 1994, Galaxy is the Internet's oldest searchable directory. Like Yahoo! and The Open Directory Project, this resource provides a robust group of pointers to mathematical resource sites on the Web. *Access*: http://galaxy.einet.net/galaxy/Science/Mathematics.html.

• **Penn State Mathematics Department.** This site is included here because of its robust offering of Web resources in the mathematical science. *Access*: http://www.math.upenn.edu/MathSources.html.

• **EulerService: European Libraries and Electronic Resources in Mathematical Sciences.** The European Libraries and Electronic Resources (EULER) Project in Mathematical Sciences provides a site for searching out mathematical resources, such as books, preprints, Web pages, abstracts, proceedings, serials, technical reports, and theses. *Access*: http://www.emis.de/projects/EULER/.



Mathematical societies

• **American Mathematical Society.** The American Mathematical Society was founded in 1888 to further mathematical research and scholarship. The society's Web site, e-MATH, is currently divided into eight audience areas for members, authors, employment, meetings, what's new in mathematics, government affairs, publications and research tools, and customer services. The site also contains a stable of electronic journals and the "MathSciNet" database, a searchable Web database providing access to more than 59 years of *Mathematical Reviews* and *Current Mathematical Publications* (from 1940 to the present). *Access:* http://www.ams.org/.

• **Society for Industrial and Applied Mathematics (SIAM).** SIAM was formed in 1952 to advance science and technology in industry. The SIAM site contains a professional opportunities area, conference highlights and a resources area containing TeX macro packages, information about mathematics in industry, and graduate programs. *Access:* http://www.siam.org/.

• **Mathematical Association of America (MAA).** The MAA bills itself as the world's largest organization devoted to the interests of collegiate mathematics. The society serves 30,000 members, which include college and university faculty, two-year college faculty, high school teachers, government and corporate workers, graduate school faculty, research mathematicians, and graduate and undergraduate students. Like many professional societies, the organization hosts a set of electronic journals, employment opportunities, and meetings. Some nice features of the Web site are the free book reviews and the Student and Student Chapter page, which provide links to student chapters that have Web sites. *Access*: http://www.maa.org/.

• **European Mathematical Society (EMS).** EMS was founded in 1990 in Madralin near Warsaw, Poland. Today its membership consists of all mathematical soci-

eties in Europe and about 2,000 individual members who joined through their national societies. *Access*: http://www.emis.de/.

Preprint servers

• **Global Directory of Mathematics Preprint and e-Print Servers.** The mission of the Global Directory of Preprint and e-Print Servers is to make available to the mathematical community the current homepage URLs and e-mail contacts of all mathematical preprint and e-print servers throughout the world. This directory provides mathematicians with a tool to find any of these servers to browse the articles posted on them and, in many cases, to post an article to the server itself. The servers are divided into three categories: umbrella servers, which cover all areas of mathematics—such as the mathematics section of the Los Alamos (Ginsparg) e-Print Archive and the MPRESS/MathNet preprints server, special subject servers, and servers administered by mathematics departments and institutes. There is an additional link to retired preprint services. *Access*: http://www.ams.org/global-preprints/.

• **Mathematics section of the Los Alamos (Ginsparg) e-Print Archive.** Started in August 1991, http://xxx.lanl.gov is a fully automated electronic archive and distribution server for research papers. Covered areas include physics and related disciplines, mathematics, nonlinear sciences, computational linguistics, and neuroscience. Users can retrieve papers from the archive either through an online Web interface or by sending commands to the system via e-mail. Users can register to automatically receive e-mail notification of newly submitted papers in areas of interest to them when papers are received in those areas. Mechanisms for searching through the collection of papers are also provided. *Access*: http://xxx.lanl.gov/archive/math.

• **Mathematical Preprint Search System (MPRESS/MathNet.preprints).** MPRESS is an index of mathematical preprints and not a full-text archive. MPRESS, supported by the Math-Net Project, started under the auspices of the European Mathematical Society. Further development of this resource is currently in the planning phase. *Access*: http://MathNet.preprints.org/.

• **University of Illinois Department of Mathematics Preprints.** The University of Illinois at Urbana-Champaign Department of Mathematics Home Page contains an archive of current and previous preprints dealing with Algebraic Number Theory, K-Theory, and the department's Faculty and Graduate Student Research Reports. Each of these sections is frequently updated. Unprocessed new submissions are also accessible. A link to the department's homepage provides information on the various types of math research being conducted at the University of Illinois at Urbana-Champaign. *Access*: http://www.math.uiuc.edu/Preprints/.

Journals

There are many lists of electronic journals available on the Web and because of the volume, this article will not point out any single journal or set of journals. Any of the directory services listed previously will have pointers to these. The mathematical societies are also a well-established point of access for e-journals. Some societies like AMS offer free full-text access to several journals, while subscription rates apply to others in the stable. For-profit publishers also provide access points to the mathematical literature.

Databases

• **MathSciNet.** MathSciNet is a searchable Web database providing access to more than 58 years of *Mathematical Reviews* and *Current Mathematical Publications* (from 1940 to the present). AMS adds approximately 65,000 reviews to the database annually. Reviews in the database are contributed by more than 5,000 mathematicians worldwide and are drawn from more than 1,600 journals in the field of mathematics. *Access*: http://www.ams.org/mathscinet.

• **Zentralblatt MATH.** Zentralblatt's database of mathematical reviews is a competitor to MathSciNet. Zentralblatt adds approximately 65,000 reviews to their database each year and claims approximately 5,000 mathematicians as reviewers world-

wide. This database contains reviews of mathematical articles from 1931 forward. *Access:* http://www.emis.de/ZMATH/.

Math libraries

Library Web sites often present a well thought-out group of resources to assist students, librarians, and others in the mathematical and science community. Following is a small subset of pointers to several the many fine library sites available.

• **University of Washington Mathematics Research Library.** *Access*: http://www.lib.washington.edu/math/.

• **The Courant Institute of Mathematical Sciences Library.** *Access*: http://www.nyu.edu/pages/cimslibrary/.

• **Physics Astronomy Mathematics Library at the University of Texas at Austin.** *Access*: http://www.lib.utexas.edu/Libs/pma/.

• **University of Notre Dame Mathematics Library.** *Access*: http://www.nd.edu/~mathlib/.

• **Cornell University Mathematics Library.** *Access*: http://www.math.cornell.edu/~library/.

Biographies

The Web is full of resources that can be used to find information about individual mathematicians, groups of mathematicians, women mathematicians, and ancient mathematicians. Of the scores of sites available, here are but a few:

• **The MacTutor History of Mathematics Archive.** Provides access to an integrated collection of more than 1,000 biographies and historical articles of a mathematical nature, with interactive birthplace maps and the famous curve applet. *Access*: http://www-history.mcs.st-and.ac.uk/history/.

• **Biographies of Women Mathematicians.** This site is an ongoing project by students in mathematics classes at Agnes Scott College, in Atlanta, Georgia. Designed to illustrate the numerous achievements of women in the field of mathematics, the site contains biographical essays or comments on prominent women mathematicians and some photos. *Access*: http://www.agnesscott.edu/lriddle/women/women.htm.

• **Catalog of the Scientific Community in the 16th and 17th Centuries.** A collection of 631 detailed biographies on members of the scientific community during the 16th and 17th centuries, with vital facts about each individual and their contributions to science. One hundred sixty-four entries in the database claim mathematics as their primary scientific discipline. *Access*: http://es.rice.edu/ES/humsoc/Galileo/Catalog/catalog.html.

• **newton.org.uk.** This "virtual museum" contains a richly populated set of resources dedicated to Newton. The author intends to broaden the scope of the site to include general history of science information and a comprehensive catalog of links. *Access:* http://www.newton.org.uk/.

Other resources

• **The Mathematics Genealogy Project.** The intent of this project is to compile information about all the mathematicians of the world. The project goal is to list all individuals who have received a doctorate in mathematics. For each individual, the site intends to show the complete name of the degreed recipient, name of the university that awarded the degree, year in which the degree was awarded, complete title of the dissertation, complete name(s) of the advisor(s). *Access*: http://hcoonce.math.mankato.msus.edu/.

• **Jahrbuch.** The aim of the JFM-project is to build a digital library for classical mathematics on the Internet. This will consist of a complete electronic catalog of mathematical publications from 1868 to 1943 and a full-text archive that stores the most relevant publications from that period. *Access*: http://www.emis.de/projects/JFM/.

Note

1. See http://madras.math.macalester.edu/snow2000/ for pictures and details about the entry and http://mathworld.wolfram.com/EnnepersMinimalSurface.html for a three dimensional model. ■

Correction

In the March 2000 issue of *C&RL News*, Susanna D. Boylston and Jeff Bullington should have been listed as the authors of "ACRL's New Member Mentoring Program." The editors regret the error.