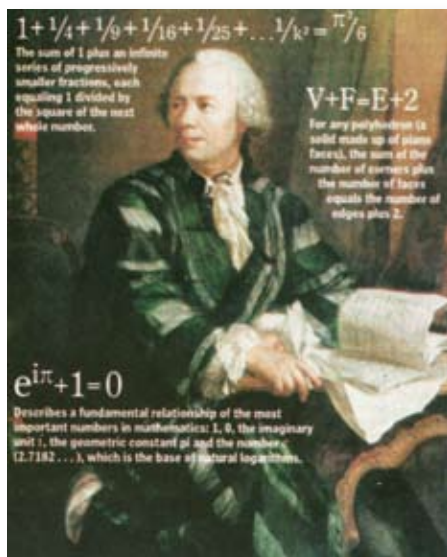


The math master

—By David Brown



If one is not a mathematician (and except for a few out there, who is?), it's going to be impossible to actually understand why Euler was such a great man. Other people will have to tell us, and we should probably believe them.

In 1988, the journal *Mathematical Intelligencer* asked its readers to list the most beautiful equations in mathematics. Of the top five, Euler, who was born in Basel, Switzerland, 300 years ago, discovered three of them, including No. 1: $e^{i\pi} + 1 = 0$. (The other two were from Euclid, who worked in the 4th and 3rd centuries B.C.)

In 2004, *Physics World* put the same question to its readers. Of the top 20 equations, Euler had two. The one listed above, known as "Euler's equation," was second only to James Clerk Maxwell's equations describing electromagnetism, which were counted as one entry.

Some have called Euler the "Mozart of Mathematics," not only because of his genius but because of his prodigious output.

Before his death at 76, he had written more than 800 papers and books on pure and applied mathematics. In 1775, he composed about one paper a week, ranging in length from 10 to 50 pages. (Twenty papers is considered a good lifetime output for modern mathematicians.) His collected works fill 25,000 pages in 79 volumes, including five of correspondence to the leading thinkers of his day.

Amazingly, that's not all of it.

More letters and a dozen notebooks will be published over the next decade. If the past is a guide, they are likely to contain work that in some sense is original even today.

Three centuries after his birth, Euler is far from a household name (unless you live in Switzerland, where his face used to be on the 10-franc note). He didn't jump out of the bathtub and run naked through the streets, like Archimedes. His head didn't get hit by an apple, like Newton's. He didn't figure out, before age 10, how to add every number from 1 to 100 in less than a minute, like Gauss.

Nevertheless, he's right there with them.

"The four greatest mathematical scientists of all time are Archimedes, Isaac Newton, Leonhard Euler, and Carl Friedrich Gauss,"

said Ronald S. Calinger, a historian of mathematics at Catholic University. He is nearly done with the first book-length biography of Euler written in English.

William Dunham, a professor of mathematics at Muhlenberg College in Pennsylvania, added that Euler is "an amazingly seminal figure in physics, as well. He wrote about optics, classical mechanics, fluid mechanics, and astronomy—in those days it was all sort of one big subject."

Euler (pronounced "oiler") was the first child of a pastor and his wife. His father had a talent for mathematics and instructed Leonhard, who enrolled in the University of Basel at age 13.

There, he studied under Johann Bernoulli, one of Europe's eminent mathematicians, and met Bernoulli's sons, Nicholas and Daniel, who were to become famous scientists themselves. Daniel was to be Euler's best friend.

The younger Bernoullis went to ST. Petersburg to join the Russian Academy of Sciences. Soon after arriving, they persuaded Catherine the I, Peter the Great's widow, to invite Euler, too. He arrived in 1727, at age 20.

Euler spent about 30 years in Russia in two long stints, interrupted by about 25 years in Berlin, to which he was called by Frederick the Great of Prussia. He never returned to Switzerland, possibly because he was offended that his Dutch-born wife would not qualify for citizenship.

Now, Switzerland is honoring him as both a native son and an example of the achievements of the Swiss diaspora. It is issuing a stamp with his image on it. Consulates around the world held lectures and other events marking the tercentenary of his birth.

"He is the very top," said Daniela Stoffel, head of cultural affairs at the Swiss Embassy in Washington, D.C.

As one would expect, Euler was good at all kinds of things. His first language was German. He wrote principally in Latin, with many papers in French (the language of the Prussian court) and a few in German. He spoke Russian. A few letters to London's Royal Society in English survive. As a young man, he studied Greek and Hebrew.

Euler contributed to essentially every field of mathematics—calculus, geometry,

number theory, and the vast realm of applied mathematics. "He was a universalist when that was still possible," said Dunham, who has just edited a book, *The Genius of Euler*, published by the Mathematical Association of America.

Nevertheless, Euler's greatest achievements may lie in what became mathematical analysis, which includes calculus and differential equations. Although Newton and Gottfried Leibniz discovered calculus, Euler systematized it, made hundreds of discoveries, and invented differential equations, which he successfully applied to mechanics and astronomy, transforming them from geometry-based disciplines to fully calculus-based ones. He almost single-handedly invented the calculus of variations, which among other things allowed the Apollo moon shot to hit its mark.

A Friend of Amicable Numbers

The Greeks discovered the first pair of "amicable numbers," **220 and 284**, where the sum of the proper divisors of one is equal to the other:

For **220**: $1 + 2 + 4 + 5 + 10 + 11 + 20 + 22 + 44 + 55 + 110 = 284$

For **284**: $1 + 2 + 4 + 71 + 142 = 220$

In the 800s, Arab mathematician **Thabit ibn Qurra** generated two more pairs:

17,296 and 18,416 (rediscovered by **Pierre Fermat**, France, 1636)

9,363,584 and 9,437,056 (rediscovered by **Rene Descartes**, France, 1638)

In 1750, **Leonhard Euler** discovered a pattern possessed by amicable numbers and generated **58** new pairs, including:

122,265 and 139,815

902,335,744 and 903,709,952

1,444,854,411 and 1,641,399,669

SOURCE: William Dunham,
Muhlenberg College
THE WASHINGTON POST

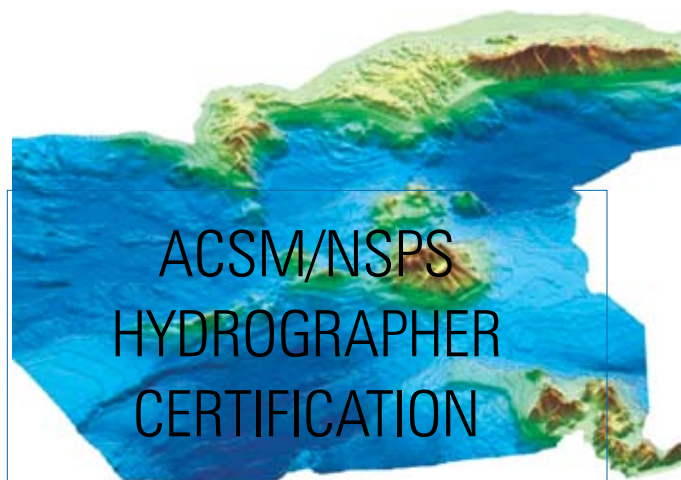
Euler also recognized the importance of the number *e*, which he named (although not after himself, as some believe). It is an irrational number approximately equal to 2.7183, the base of natural logarithms and essential to the calculation of such things as compound interest. Like pi, it is also a value that pops up in all sorts of unexpected places—one of universe's favoured numbers.

Euler's achievements were all the more remarkable because he lived a life that was both relatively normal and quite difficult. He married twice and fathered 13 children. Only five of them survived into adolescence. He played the clavier and composed a small corpus of music based on mathematical equations. (A concert in St. Petersburg in May as part of an Euler festival.) He was a masterful chess player. He liked to go to the Berlin zoo with his children and watch the bear cubs.

In his early thirties, Euler lost most of the sight in his right eye. He developed a cataract in the other and was legally blind for the last dozen years of his life. As his sight failed, he took to writing on a huge slate on a round table, dictating his papers to a Swiss secretary.

He worked incessantly even after his eyesight failed, and was, it appears, a happy man. On the day he died in St. Petersburg, Sept. 18, 1783, his slate reportedly contained a calculation of the height to which a hot-air balloon could rise. News of the first balloon ascent, in Paris the previous June, had recently arrived. Says Dunham: "You could hardly argue that he wasted a day of his life."

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Projections: Engineers and technology workers

The federal government estimates that the United States will lack 15 million engineers and technology workers over the next 15 years. The U.S. currently graduates about 75,000 engineers each year compared with China and India, which each average more than 300,000 engineers per year. Programs exist at the University level to increase interest in engineering and technology. However, studies show that the earlier students get involved in a field, the more likely they are to stay with it as a profession. Project Lead The Way (PLTW) has been reaching out at the high school level—going so far as to even reach into middle schools to interest students in these fields of engineering and technology. As of the 2006/2007 academic year, the PLTW network comprises more than 1,700 schools in 46 states and the District of Columbia. Enrollment for the 2006-2007 school year is more than 175,000 middle school and high school students.