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WHY NUMBERS MATTER

MATHEMATICS WITHOUT NUMBERS

I watch movies, but sometimes with sadness. In the movie **Dr. Zhivago**, our hero poet—played by Omar Sharif—emotes, but there is **none of the poetry**—the movie character Zhivago is probably the least interesting person in the movie. The real heroes are the other characters, such as Laura, and the birches and the fields of flowers: we are not given the poet, and are given none of the poetry which occurs in the book, where Pasternak includes at its end a small book of Zhivago's poems. In the recent movie, **A Beautiful Mind,** we are shown a Nobel Prize-winning mathematician, John Nash, but are not told, not shown, what his accomplishment was: We are given **none of the numbers**. We are given movies without the content which would give them meaning. I love books like **Zhivago** (with Zhivago's **Poems**), or G.B. Shaw's **Man and Superman** (where we are given, at the end, a small book written by the hero).

We do now have, on television, the program **Numbers,** in which real mathematics is used.

It is also true with the mathematics we are taught in school. Even when we are told "about," we are not given. We are shown people who live and die for ideas, without being told what the ideas are.

PLATO

Over the entrance to **Plato's Academy** were written the words:

"Let no one destitute of geometry enter my doors."

To Plato, the real world was the world of ideal forms, to which mathematics was the key. When asked, "What does God do?" Plato answered, "God always geometrizes."

EUCLID

Many people have, not merely a lack of appreciation, but a fear of mathematics. This is a shame, because mathematics is **beautiful, elegant, and powerful**. One of the world's Great Books is Euclid's **Geometry**. Abraham Lincoln (in Carl Sandburg's **Lincoln**) learned to think reading Euclid by firelight, writing out its theorems with coal on a shovel. Until recently, Euclid was a

necessary part of the education of every civilized person. One of the delights of life and education is working through Euclid's Elements. As Edna St. Vincent Millay has written in a sonnet:

"Euclid alone has looked on beauty bare."

THE GREAT BOOKS

Others of the **Great Books** (the essential works of Western Civilization, which all civilized people acknowledge as the treasures of our culture) are also works in mathematics, including Newton's **Principia.** A fuller list would include: Euclid, Archimedes, Apollonius, Nicomachus, Ptolemy, Copernicus, Kepler, Galileo, Descartes, Pascal, Poincare, Einstein, Bohr, Hardy, Heisenberg, and Schrodinger. One is not educated without having read not only the Great Books in Literature, but also those in science and mathematics.

MATHEMATICIANS ON MATHEMATICS

"It is impossible to explain honestly the beauties of the laws of nature in a way that people can feel, without their having some deep understanding of mathematics."..."The Great Architect seems to be a mathematician." "To those who do not know mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty, of nature."..."If you want to learn about nature, to appreciate nature, it is necessary to understand the language she speaks in." "All the intellectual arguments that you can make will not convey to deaf ears what the experiences of music really is. In the same way, all the intellectual arguments in the world will not convey an understanding of nature to those of 'the other culture.'"--- Richard Feynman.

Feynman refers to C.S. Snow's **The Two Cultures**, where Snow wrote of the separation of Literature and Science, and of the blindness of many educated in Literature to the beauty and power of Science (which includes mathematics). This remains sad but true. Too many people are even proud of being '**innumerate**" (The mathematical equivalent of being "illiterate"), and don't even know the ABCs of numbers, such as proportion, scale, and probability. It is similar with Physics, where few people know **the Three Laws of Thermodynamics**, which should be an essential part of education. At least people have heard of Einstein's Theory of Relativity: $e = mc^2$, thanks to the nuclear age.

To Carl Friedrich Gauss, "Mathematics [was]...the Queen of the Sciences, and Arithmetic, the Queen of Mathematics."

In school, we learn numbers, to add and subtract, but little more.

**It is as if we were taught letters, but were never told
about words, books, poems, and novels.**

People learn numbers, and forget them, because they never learn what is possible with numbers. They are not even introduced to the great mathematicians and their accomplishments.

"Mathematics, rightly viewed, possesses not only truth, but supreme beauty—a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show."---Bertrand Russell, in his autobiography. In the same work, Russell wrote on contemplating suicide when he was a youth, but he did not "because I wished to know more of mathematics."

"There is a largeness about mathematics that transcends race and time: mathematics may humbly help in the market place, but it also reaches to the stars. To one, mathematics is a game (but what a game!) and to another it is the handmaiden of theology. The greatest mathematics has the simplicity and inevitableness of supreme poetry and music, standing on the borderland of all that is wonderful in Science, and all that is beautiful in Art. Mathematics transfigures the fortuitous concourse of atoms into the tracery of the finger of God."--- H.W. Turnbull. 141.

When one reads the history of mathematics, or the great philosophers, a constant theme, with respect to mathematics, is both its necessity and its **beauty.**

The Great Mathematicians should be known by all, and appreciated for their accomplishments, each one building on the work of his predecessors. The Roll Call would include (a partial list): Thales, Pythagoras, Hippocrates, Zeno, Plato, Eudoxus, Euclid, Archimedes, Decartes, Fermat, Pascal, Newton and Leibnitz, Euler, Gauss.

Voltaire, with respect to Newton, recorded his pride at having lived for a time "in a land where a Professor of Mathematics, only because he was great in his vocation, was buried like a king [Newton was buried with honor at Westminster] who had done good to his subjects." (Turnbull 105). Think of the equivalent great respect held in the 20th Century United States for Einstein.

To Pythagoras, numbers were not merely attributes, but rather the stuff out of which all objects we see or handle were made—the rational reality: The principles of mathematics were the principles of all things.

THE MONA LISAS OF MATHEMATICS

The Mona Lisas of mathematics are its great theorems, which every civilized person should know (or at least know about). William Durham lists some of them, below. One could differ about these, as one differs about the **100 Great Books**, but the following would be on most mathematicians' lists.

(1) The Quadrature of the Lune (Hippocrates)
(2) The Pythagorean Theorem (Euclid)
(3) The Infinitude of Primes (Euclid)
(4) The Determination of Circular Area (Archimedes)
(5) The Formula for Triangular Area (Heron)
(6) The Solution of the Cubic (Cardona)
(7) The Binomial Theorem and The Calculus (Newton)—(and the Law of Gravity)
(8) The Non-Denumerability of the Continuum (Cantor)

FAMOUS FRENCH & IRISH MATHEMATICIANS

For amusement, I once asked my daughter, Margaret, to name three famous French mathematicians, which she did, and then I asked her to name their accomplishments, which she also did, much pleasing her father. Her choices were **Pascal** (Pascal's Wager), **Descartes** (the union of geometry and mathematics), and **Fermat** (Fermat's Theorem). She was not, however, able to identify famous Irish mathemeticians ("Yes,Virginia, there is a Santa Claus." There **are** great "Irish" mathemeticians [George Boole, of Boolean Logic, William Hamilton of Quaternions, Bishop Berkeley of **The Analyst**, the criticism of Newton's Calculus]. But I give students extra credit if they lie and tell me George Boole was Irish).

GREAT EVENTS & SCANDALS

There are also great events in the history of mathematics, and stories associated with them, such as the **logical scandals** created with the discovery by the Greeks of **incommeasurable numbers, Zeno's Paradoxes,** or **the flaw (pace Bishop Berkeley) in Newton's Calculus**. Many have died, and have been killed, for mathematical ideas, such as **Zero.** Even today, the uncertainty principles of Heisenberg and Gödel are profoundly unsettling for those who believe that science—in terms of the scientific method—is possible. At the very entry into mathematics, we find paradoxes, such as that of the **Last Number Paradox** (Is there a Last Number, or an Infinity of Numbers? If there is an infinity, how can mathematics be a deductive science?)

Literate people should read in mathematics, just as they read in literature and philosophy, for instruction and for pure beauty.

Recommended Books & Programs/Movies

Boyer, Carl B. **A History of Mathematics**. 2nd Ed. Revised by Uta C. Merzbach. John Wiley & Sons, Inc. New York. 1968 (1991).

Wentworth, G.A. **Plane and Solid Geometry**. Ginn & Company. New York. Revised Edition. 1888 (1889).

Dunham, William. **Journey Through Genius: The Great Theorems of Mathematics**. John Wiley & Sons Inc. New York. 1990.

Turnbull, Herbert Westren. **The Great Mathematicians**. Edited by John R. Newman. New York University Press. 1929 (1962).

Von Neumann, John. Ed. **The World of Mathematics**. 4 vols. Simon & Schuster. New York. 1956.

Feynman, Richard. **The Character of Physical Law.** Modern Library. New York. 1965 (1994). Introduction by James Gleick. Especially Chapter 2: "The Relation of Mathematics to Physics."

Beckmann, Petr. **(A History of) Pi.** St. Martins Press. New York. 1971.

Casti, John L. **Five Golden Rules: Great Theories of 20th-Century Mathematics—and Why They Matter**. John Wiley & Sons, Inc. New York. 1996.

Livio, Mario. **The Golden Ratio: The Story of Phi, The World's Most Astonishing Number.** Broadway Books. New York. 2002.

Seife, Charles, **Zero: The Biography of a Dangerous Idea**. Penguin Books. New York. 2000.

David Berman. **Berkeley: Experimental Philosophy**. Phoenix. London. 1997.

George Berkeley. **"The Analyst: a Discourse Addressed to an Infidel Mathematician."** The premises of mathematics (esp. calculus) rest on no surer foundations than religion. "He who can digest a second or third fluxion, a second or third difference, needs not, methinks, be squeamish about any point in Divinity." "And what are these fluxions? The velocities of evanescent

increments." Danzig noted both the rigor and the **"splendid Irish humor"** in Berkeley's criticism of Newton.

David Berlinsky. **A Tour of The Calculus**. 1997.

Tobias Danzig. **Number. The Language of Science**. 4th Edition. Penguin Books. New York. (Original 1930. 4th ed. 1954) 2007. This is a great, simple book, praised by Einstein.

Paulos, John Allen. **Innumeracy: Mathematic Illiteracy and Its Consequences**. Vintage Books. New York. 1988 (1990).

Phillips, John L. **Statistical Thinking: A Structural Approach**. W.H. Freeman & Co. San Francisco. 1973.

Two Movies & TV

"**Contact**" The Movie: In which aliens communicate with Earth by the use of **Prime Numbers.**

"**A Beautiful Mind**." The Movie: the life of John Nash, who won the **Nobel Prize** for his work in Game Theory.

"**Numbers**." Friday evenings (formerly at 10:00pm, now at 9:00 pm). A mathematician at Cal Tech helps his FBI Special Agent Brother solve crimes. Modeled on Richard Feynman who also won the **Nobel Prize**.

NASH'S THEOREM

For the interested reader, **Nash's theorem** was:

"Any n-person, noncooperative game (zero-sum or nonzero-sum) for which each player has a finite number of pure strategies has at least one equilibrium set of strategies."

This led to the first Nobel Prize for pure mathematics, shared by Nash with John Harsanyi and Reinhard Selten. This theorem provides a mathematical expression of the idea of "rational action." This built on the earlier Nobel Prize winning work of John Newman.

I think that people should always go "**ad fontem**" (to the source). For example, if one learns of that principle of logic, by the Franciscan William of Occam, **Occam's Razor,** why not learn the

actual words (in English and Latin)? All things being equal, the simplest answer is the best. ***"Entia non sunt multiplicanda praeter necesitatem."***

Note: As some of you may have suspected, this entire essay was written just to make the point that there are Irish mathematicians.

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