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A Note on the Names of Mathematical Problems and Puzzles

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This note examines selectively the names given to mathematical problems, puzzles, conjectures, and equations. It shows that many derive from the surnames of their inventors. Others, however, are associated with narratives that describe some salient aspect of the problem or puzzle.

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While writing a paper entitled "The Representation of Mathematics in the Media" for a weeklong symposium ("Workshop on Semiotics, Cognitive Science and Mathematics," 14–18 March 2011) sponsored by the Fields Institute for Research in Mathematical Science located in Toronto, it became evident that many mathematical problems, puzzles, conjectures, and equations had specific names attached to them. To be sure, many of the problems and hypotheses have the name(s) of their discoverer(s). One example is the "Riemann hypothesis" (1859) named after Bernhard Riemann (1826–1866), which deals with the distribution of zeros in the "Riemann zeta function." In fact, the "Riemann hypothesis" is one of seven mathematical problems designated by the Clay Mathematics Institute (Cambridge, MA) in May of 2000 as worthy of receiving a one million prize for its resolution. This problem is the only one that remains from a list of mathematical problems drawn up by the German mathematician David Hilbert (1862–1943) and delivered at the International Congress of Mathematicians in Paris in 1900. Of these twenty-three original "Hilbert Problems," only the Riemann hypothesis (Devlin 2002: 19–62) remains unsolved. Keith Devlin (2002: 19–62) discusses all seven of these problems in his book *The Millennium Problems: The Seven Greatest Unsolved Mathematical Puzzles of Our Time*.

The other six unsolved mathematical problems specified by the Clay [Landon T. Clay, Boston business man] Mathematics Institute as worthy of the one million dollar award, and collectively referred to as the "Millennium Prize Problems" are:

1. "The Yang-Mills theory and the Mass Gap Hypothesis" (Devlin 2002: 63–104) named after Chen-Ning Franklin Yang (1922–), a Chinese-American physicist and Nobel Prize winner (1957) and Robert Mills (1927–), an American physicist. This theory was developed in 1954 and addresses gauge theory.

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2. "The P vs. NP problem" (Devlin 2002: 105–129) is an unsolved problem in computer science introduced in 1971 by Stephen Cook (1939–), an American computer scientist and mathematician. This problem deals with computational complexity theory.
3. "The Navier-Stokes equations" (Devlin 2002: 131–155) refer to Claude-Louis Navier (1785–1836), a French engineer and physicist and George Gabriel Stokes (1819–1903), an English mathematician and physicist, which describes the motion of fluids.
4. "The Poincaré conjecture" (Devlin 2002: 157–187) is named for Henri Poincaré (1854–1912), a French mathematician, physicist, and philosopher. The problem deals with topology. It was proven by Grigori Perelman (1966–), a Russian mathematician in 2003. Perelman received the one million dollar Clay Mathematics Institute Millennium Prize on March 18, 2010.
5. "The Birch and Swinnerton-Dyer Conjecture" (Devlin 2002: 189–212) refers to Bryan John Birch (1931–) and Peter Swinnerton-Dyer (1927–), both English mathematicians, who studied the algebraic properties of elliptic curves.
6. "The Hodge conjecture" (Devlin 2002: 213–228) refers to W. V. D. Hodge (1903–1975), a Scottish mathematician, and it deals with algebraic geometry.

Marcel Danesi, a Professor of Anthropology and Semiotics at the University of Toronto, and a mathematician, authored a book entitled "*The Liar Paradox and The Towers of Hanoi: The Ten Greatest Math Puzzles of All Time*" (Danesi 2004). This note also addresses the names of these ten significant mathematical puzzles together with a brief discussion. A description of each puzzle appears below. To learn the answers to these mathematical puzzles, the reader will have to consult Danesi's book.

1. "The Riddle of the Sphinx" (Danesi 2004: 5–25) refers to the Sphinx, a statue with the head and breasts of a female, a lion's body, and a serpent's tail, and a bird's wings. This legendary creature guarded the entrance to the city of Thebes, a city in Greece located north of the Cithaeron range dividing Boeotia and Attica. This well-known riddle is stated in the following way: "What has four feet in the morning, two at noon, and three at night?" The legend states that Oedipus, the mythical Greek king, provided the correct answer. Upon hearing the correct response the Sphinx killed itself, and Oedipus entered Thebes.
2. "Alcuin's River Crossing Puzzle" (Danesi 2004: 27–45) alludes to Alcuin (735–804), a medieval scholar, and advisor to Charlemagne (742?–814). The puzzle alludes to the minimum number of times a traveler will have to cross a river in a single boat that only holds two items at a time. The traveler has to determine how to convey a wolf, a goat, and a large cabbage to the other side one at a time so that those that remain are safe. This puzzle has multiple variants.
3. "Fibonacci's Rabbit Puzzle" (Danesi 2004: 47–66) refers to Leonard Fibonacci (1170–1240), a Pisan mathematician. The puzzle concerns the number of rabbits that will be produced in a cage during a one-year period if the original rabbits produce a single pair of a male and a female each month.
4. "Euler's Königsberg Bridge Puzzle" (Danesi 2004: 67–84) alludes to Leonhard Euler (1707–1783), a Swiss mathematician. The puzzle poses the question of

whether or not it is possible to cross the seven bridge of the German town of Königsberg that pass over the Pregel River by traversing each bridge only once. It is considered the first theorem of graph theory.

5. "Guthrie's Four-Color Problem" (Danesi 2004: 85–103) refers to Francis Guthrie (1831–1899), an English mathematician. The problem poses the question about the minimum number of tints needed to color the various regions of a map distinctively in order to avoid any two regions with shared borders from having the same color. The specific challenge in the four-color problem is this: What is the minimum number of colors necessary to fill in a map so that adjacent countries always have a different color?
6. "Lucas's Towers of Hanoi Puzzle" (Danesi 2004: 105–123) is a reference to François Anatole Lucas (1842–1891), a French mathematician. Invented as a toy for children in 1883, this puzzle contains three pegs on a block of wood. One of the pegs contains a set of discs with the largest one at the bottom of the peg. The challenge is to move all of the discs from the first one to the third one without allowing a larger disc to be placed on a smaller one. Lucas marketed this puzzle under the name N. Claus de Siam (an anagram of Lucas d'Amiens [his birth place]). This puzzle is based on the mathematical notion of exponents and exponential growth. The idea for the Towers of Hanoi can be traced to the Italian mathematician Girolamo Cardano (1501–1576) who situated his verbal description of the mathematical game in a monastery in Hanoi.
7. "Loyd's Get Off the Earth Puzzle" (Danesi 2004: 125–140) refers to Sam Loyd (1841–1911), who studied engineering, and ultimately became the problem editor for *Chess Monthly* magazine. Loyd's puzzle is a so-called "cut-and-slide: trick, which involves the attachment of a smaller paper circle to a larger one. The artwork made the circle appear to be the Earth. It contained thirteen Chinese warriors. When the smaller circle is slightly rotated, one of the warriors disappears. The actual warriors are constructed from small pieces of paper designed to represent different body parts (arms, legs, and so forth). This puzzle is based on applied geometrical principles.
8. "Epimenides' Liar Paradox" (Danesi 2004: 141–157) was devised by Zeno of Elea (*circa* 489–435 BCE). The puzzle involves the following statement (Dansei 2004: 143): "The Cretan philosopher Epimenides [6th century BCE] once said: 'All Cretans are liars.' Did Epimenides speak the truth?" This statement is contradictory because the person speaking is a Cretan. This paradox has numerous variants.
9. "The Lo Shu Magic Square" (Danesi 2004: 159–175) is a reference to the Chinese puzzle that involves the arrangement of the first nine integers (1 to 9) in a square. It is called a magic square in English. The recent popular game and logic puzzle Sudoku incorporates aspects of the magic square. "Lo Shu" means "Lo River scroll."
10. "The Cretan Labyrinth" (Danesi 2004: 177–190) refers to a prison constructed on the island of Crete by the legendary Daedalus for Minos, the king of Crete, and it is considered to be an architectural puzzle. The Cretan labyrinth gained popularity in the form of printed puzzles in which the participant uses a pencil to trace a path to some desired point.

The purpose of this note is to stimulate an interested onomastician to write a comprehensive article on the subject of the names of various mathematical problems, puzzles, conjectures, and equations. As noted above, many are named for the originator(s), while others refer to specific narrative aspects used to frame the puzzle.

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Notes on Contributor

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