

# Zero: The Riddle of Riddles

## Ritika Sood

The concept and implications of the number zero have dominated the world of mathematics for centuries, causing many of the world's greatest mathematicians to suffer from insomnia. The world experienced a paradigm shift when this concept of nothingness was 'discovered' and given a definition. The number zero is inherently linked to our everyday lives. In economics, zero represents a depleted

“ The fear of [zero] led many a corporation to readdress their policies ”

bank account. In the recent economic crisis, the fear and, in some cases, occurrence of a depleted bank account led many a corporation to readdress its policies. A number near zero is also the rate that the Federal Reserve claimed to start charging, or rather, not charging, commercial banks for short-term loans in December 2008, in an attempt to defibrillate the economy [1]. The mystery of zero is also present in the scientific world, where absolute zero defines the theoretical temperature characterised by the complete absence of heat. Zero is also the proposed atomic number of the theoretical element tetra-neutron, a hypothesized stable cluster of four neutrons whose existence is not supported by laws of nuclear forces [2]. In the past, zero was analyzed as a nothing that is an actual something—as the riddle of riddles. To be able to fully appreciate the significance of the number zero, “that *O* without a figure”, as Shakespeare called it, requires an understanding of its discovery, the progression of its presence and the resistance it encountered throughout history [3].

The Ancient Greeks were philosophically unsure about the concept of nothingness. Near the end of the eighth century BC, the notion of zero was worked into the story of Odysseus and Polyphemos, the Cyclops [4]. However, there is no trace of zero as a number in the history of Homeric or Classical Greece. It is fascinating that the Greeks, to whom many scientific, mathematical and artistic discoveries can be attributed, were unable to conceptualize zero. The reason for this is that the majority of Greek mathematical achievements were based on geometry. Greek mathematicians did not need to name their numbers, as they worked with numbers as lengths of lines. Furthermore, the lack of positional notation in Greek mathematics meant that the number zero and its mathematical properties remained undiscovered [5].

Despite its potential to extend the empire of numbers, zero was not treated as a number itself until 5th century AD in India. Prior to this, it was no more a number than a comma is a letter. This raises the question, what did it take for this immigrant to gain citizenship in the Republic of Numbers? Unlike ideas, trends and fashions, which have

undergone radical changes throughout the ages, the Republic of Numbers is far more conservative, reluctant to accept new members and adamant in never letting them go once sworn in. Take irrational numbers as an example; 2500 years after the proof of their existence allegedly by Hippasus, we cannot do without them, although the sense in which they exist as numbers is still debated.

Going back in history, the use of zero can be found in Babylonian and Mayan mathematics but the discovery of the use of zero as a number is attributed to Indian mathematicians. For over 1000 years, the Babylonians had a place-value number system that did not include zero as an empty place indicator. This is somewhat surprising, as one would consider this to be an important feature. Babylonian mathematicians would not distinguish between 5107 and 517; rather, the context would show which number was intended. It was not until around 400 BC that the Babylonians began using two wedge symbols where we would now put zero to indicate which was meant [5].

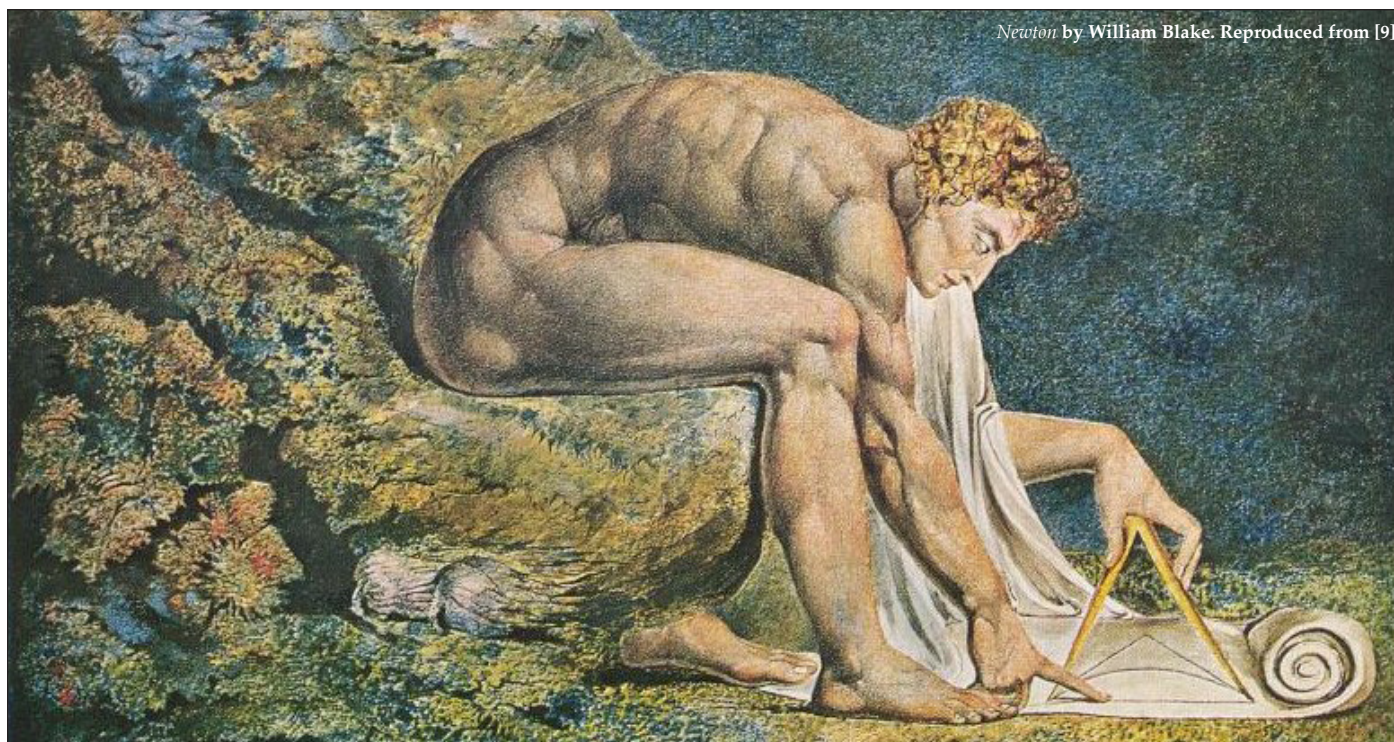
The Mayans developed a place-value number system with a zero, which they denoted by a shell symbol. What is interesting is that the use of zero in Mayan mathematics can be traced back prior to the introduction of their place-value number system which is a remarkable achievement. However, their concepts did not find their way into other societies.

The birth of the concept of zero as a number and not merely a symbol for separation can be attributed to Indian mathematicians. The very word 'zero' finds its etymological root in the Sanskrit word *śūnya*, meaning 'void' or 'empty' [7]. The first recorded use of zero as a number dates back to 876 AD in India. A stone tablet carrying an inscription regarding Gwalior, a town 400 km south of the capital has been accepted by historians as the first record of the number.

“ If one were able to divide by zero, then all numbers would be the same ”

The inscription presents the dimensions of this garden, 187 by 270 hastas (a traditional Indian unit of length, measured from the elbow to the tip of the middle finger, approximately 18 inches) which was being grown to produce enough flowers to provide 50 garlands per day for the local temple. This information was detailed on the tablet, and both of the numbers 270 and 50, were inscribed very similarly to how they appear on this page, the only difference being that the 0 was slightly smaller and slightly raised [5].

For zero to be held in the same regard as other numbers, knowledge of how to add, subtract, multiply and divide with it was required, though these operations are now taken for



Newton by William Blake. Reproduced from [9]

granted in simple arithmetic calculations. The Indian mathematicians Mahavira, Bhaskara and Brahmagupta set out to undertake this very task. They agreed that a number multiplied by zero is zero and that a number remains unchanged when it is diminished or augmented by zero. However, the issue which caused disagreements among the men was the division of a number by zero [5]. Experience and common sense tell us that two different numbers do not hold the same value, that 5 is not the same as 15, for example. If one were able to divide by zero, then all numbers would be the same. Let us apply the method of proof by contradiction. Any number multiplied by zero is zero – for example,  $5 \times 0 = 0$  and  $15 \times 0 = 0$ . Hence,  $5 \times 0 = 15 \times 0$ . If division by zero were possible, this would yield  $5 \times 0/0 = 15 \times 0/0$  and the zeroes would cancel leaving us with the result 5 equals 15! Hence in elementary arithmetic, dividing by zero gives an undefined value. The rules governing the use of zero as a number in its own right (with the exception of division by zero) appeared for the first time in Brahmagupta's book *The Opening of the Universe*, written in c.628 [8].

The brilliant work of the Indian mathematicians was transmitted west to Islamic and Arabic mathematicians, as well as east to China. The Italian mathematician Fibonacci was one of the main people to bring the Indian numerals to Europe [5]. In his book *Liber Abaci* published in 1202, he described the nine Indian symbols along with the sign 0. What is significant is that Fibonacci did not treat 0 in the same way as the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9. In his work, he speaks of the 'sign' zero, while he refers to the other symbols as numbers. Despite the incredible achievements

of Indian mathematicians and subsequent work by Arabic and Islamic mathematicians, Fibonacci was unable to reach the same level of sophistication in his treatment of zero. While his book had a profound effect on European thought, zero was not widely used in Europe for a long time. An example of the resistance encountered in the acceptance of zero by European mathematics is that in the 1500s, Italian Mathematician Cardan solved cubic and quartic equations without using zero. His work would have proven to be far easier had he done so. In fact, it was only in the 1600s that zero came into widespread use.

In spite of being a well established concept, zero is still a source of difficulty. On 1 January 2000, when people around the world celebrated the new millennium, they were in fact only celebrating the completion of 1999 years, as when the calendar was established, no year zero was accounted for. This is why the third millennium and the 21st century began on 1 January 2001, something that many have had a difficulty understanding. After exploring the complex history of the number zero, the fact that it is still causing confusion is hardly surprising. Let us return to the present and the Federal Reserve's strategy of charging a near zero rate for short term loans, which triggers the question: can 'nothing' save us? After the recent economic turmoil, zero seems to be the option to settle for in financial terms. When you consider the alternative... it sure beats going negative. ■

*Ritika Sood is a second year student studying Chemical Engineering at King's College.*

#### References:

1. Isidore C. Fed: Economy better, rates to stay low. CNNMoney.com [Online]. 2010 Apr 28 [cited 2010 Aug 13]. Available from: [http://money.cnn.com/2010/04/28/news/economy/fed\\_decision/index.htm](http://money.cnn.com/2010/04/28/news/economy/fed_decision/index.htm)
2. Samuel E. Ghost in the atom. New Scientist. 2002 Oct 26;2366:30-3.
3. Shakespeare W. King Lear, Act 1, Scene 4.
4. Homer. The Odyssey Book IX: The Tale of Odysseus: Lotus-Eaters, Cyclops. Lines 360-409. Translated by Murray AT
5. O'Connor JJ, Robertson EF. A history of zero [Online]. University of St. Andrews; 2000 Nov [cited 2010 Aug 11] Available from: <http://www-history.mcs.st-and.ac.uk/HistTopics/Zero.html#s31>

6. O'Connor JJ, Robertson EF. Mayan mathematics [Online]. University of St. Andrews; 2000 Nov [cited 2010 Aug 13]. Available from: [http://www-history.mcs.st-and.ac.uk/HistTopics/Mayan\\_mathematics.html](http://www-history.mcs.st-and.ac.uk/HistTopics/Mayan_mathematics.html)
7. Ciment J. Zero [Online]. 2007 [cited 2010 Aug 13]. Available from: [www.encyclopediawebsite.com/disc/entries/zero.doc](http://www.encyclopediawebsite.com/disc/entries/zero.doc)
8. O'Connor JJ, Robertson EF. Brahmagupta [Online]. University of St. Andrews; 2000 Nov [cited 2010 Aug 13]. Available from: <http://www-history.mcs.st-and.ac.uk/Biographies/Brahmagupta.html>
9. PD, Wikipedia. <http://en.wikipedia.org/wiki/File:Newton-WilliamBlake.jpg>