Much Ado About Nothing

Philip J. Schneider
Kit Kat Club
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It has been said the topics for essays come much easier after the first one. I knew the subject of this essay the evening of my so-called "freshman" paper, *The Hearth and the Stone*. In this essay, I explored the reasons for the collapse of the Mayan culture. One of the points I made as evidence of their sophistication to underscore the difficulty explaining the sudden decline, was the fact that they "understood mathematics and were the first culture to develop the concept of zero." Fred Milford asked me why this was significant. Unable to provide Fred with an answer, I decided then and there on February 17, 1997, that this would be the subject of tonight's essay.

This may come as a surprise to fellow Kit Kat members, but Fred must be some sort of intellectual trendsetter. Since he asked me this question, two best sellers have been written on this topic: *Nothing that Is – The Natural History of Zero*, by Robert Kaplan[1], and *Zero – The Biography of a Dangerous Idea*, by Charles Seife[2]. I recently saw the latter book in an airport bookstore in Cincinnati, which would indicate that this really is a mainstream topic! On a recent flight, reference was made to these best sellers and how the subject of mathematics is currently in vogue in an article titled "Hip 2 B^2" written by a self described "math geek" that was published in the airline magazine on board[3]. In the article, the author makes fun of himself and fellow classmates who were "the most notably deficient in social graces" calling each other "minus 459" – an absolute zero. I even saw the discovery of the importance of zero listed on the "Millennium List" for the time period of years 1000 – 1371 on a web page titled "Biography of the Millennium."[4] Humor, books, movies…what are we on to here? An easy essay, perhaps?

Nothing could be further from the truth. One would think that having these two books, along with a work titled *Signifying Nothing – The Semiotics of Zero* by Brian Rotman[5], that the writing of this essay would have been simple. These books have been challenging to read, and discuss dimensions of the seemingly simple topic of zero in very sophisticated historical, mathematical, cultural, economic, artistic, religious, and philosophical terms. When we discussed the topic of my essay tonight, Jim Luck asked me if he should invite a philosopher or mathematician this evening. I suggested he invite both! Perhaps this validates the difficulty I had answering Fred's original question. I guess I can feel a little better about being stumped that cold, February evening.

So, the topic of my essay, in Kit Kat tradition, is "Much Ado About Nothing." Perhaps you will feel this way too after I am finished. I do plan to try to answer the question "why is the concept of zero significant?" in terms that both you and I can understand. I will do this by discussing the historical evolution of zero from both a functional and philosophical perspective, and the evolution of zero as both an intriguing and cultural concept. I know that some of you are experts in the areas that I will touch upon tonight, and encourage you to add to the content of this essay if the discussion that follows.

Perhaps a good way to start is to reflect on western culture, even with some of your habits today, as a framework for understanding with the discovery of zero is heralded as a cultural accomplishment. Let me ask you a question. Are we on the first floor or second? During a recent trip to Europe (London, in fact), I was reminded that the US is one of the only countries that considers the "ground floor" to be the "first floor" after I admitted to pressing the "one" button by mistake a few times intending to return to the lobby. Start counting…"one, two three…" Get out a calendar. Is there a "day zero"? Except for the books to which I made reference, where do they start – chapter one, page 1. Look at the number pad (or dial) on a telephone. It starts with the number one. Zero has been added, but after the nine along with other non-numeric symbols. There is evidence that we ignore zero, or at least treat it a little differently.

On the other hand, there is evidence that zero is accepted as part of our daily lives as reflected by common expressions such as: "ground zero", "zero-sum game", "zero hour" "zero tolerance policy", "zero defects", and so forth.

Maybe the first place to start our search (in the spirit of Kit Kat founder, Samuel Johnson) is in the dictionary. The definitions of "zero" in my aging, frayed 1961 edition of *Webster's New Collegiate Dictionary*[6] (the thin paper edition) include the following:

a. Noun
   1. Arithmetic. A cipher; naught. (of course, I had to look up the definition for naught. It is: "the arithmetic character 0; zero; also, a zero or cipher.") Big help.
   2. The point of departure in reckoning; specifically, the point from which the graduation of a scale, as of a thermometer, commences.
   3. The lowest point.
   4. A type of light, single-seated Japanese fighter plane. (Something for Fred's next essay)

b. Adjective
   1. Meteorology.
      A. Designating a ceiling that is limited to fifty feet or less in a vertical direction.
      B. Designating a visibility in a horizontal direction that is limited to 165 feet (1/32 mile).
      C. Zero-zero indicates visibility both vertically and horizontally (zero-zero conditions)

To further explore, the definition of "cipher" reads:

a. Empty.
b. Math. A character or symbol (written 0) denoting the absence of all magnitude or quantity: naught; zero.
c. One that has no weight, worth, or influence; a nonentity.
d. Any Arabic numeral.

What is it: a starting point? The lowest point? A description of limited conditions that is something more than nothing? Or nothing at all? If a clear definition eludes us, how can we address the issue of significance?

For Christmas in 1992, my father gave me a book titled Brewer's Dictionary of Phrase and Fable[7]. In it he inscribed "Many times I have slaked the thirst of my curiosity by dipping into this well – I'm sure it is deep enough for you to do that as well." Certainly here is a place to find an answer to Fred's question. Not much help here either, however. Sorry Dad.

"Zero (Arabic, a cipher). The figure 0; nothing; especially the point on a scale (such as that of a thermometer) from which positive and negative quantities are measured; on the Centigrade and Réaumur thermometers fixed at the freezing point of water; on the Fahrenheit 32° below freezing point." Reference is also made to two previously mentioned phrases containing the word "zero": "absolute zero is a point at which it would be impossible to get any colder; *i.e.* that at which it is totally devoid of heat (estimated to be at or about -273° C)" and "zero hour – a military term (first used in World War I for the exact time at which an attack is to be begun. From this are timed the subsequent operations, *e.g.* zero + 3 means three minutes after zero hour." I am still not sure why zero is significant.

On to the encyclopedia![8] Here it is said that "zero" is a term applied to the number representing naught, denoted by the symbol 0. It is noted that the fundamental arithmetic properties of the *number* (note the terminology here) zero are: $a + 0 = a$, $a - 0 = a$, and $a \times 0 = 0$, in which a is any number; and $0 \div b = 0$, in which b is any number other than zero. It is further stated that "division by zero is not defined and therefore is an inadmissible operation. In the real-number system, zero is the only number that is neither negative nor positive, and represents the boundary between negative and positive numbers. This property makes zero the natural starting point, or origin to many scales, as on the coordinate axes and on thermometers."

Now, I have had enough high school math to realize that zero has some unique properties compared to other number, but so does the number "one." For example, $a \times 1 = a$ where a is any number; and $b \div 1 = b$ where b is any number other than zero. No single number acts like one either.
These rules and statements add a little to our appreciation of the uniqueness of zero, but hints at a conceptual dimension to zero that broadens its significance from just an association with mathematics to a broader philosophical and cultural context. For example, what is "nothing?" Can we imagine the nothingness that might have existed before creation? Who can we have a number that cannot be used in a typical way and results in "inadmissible operations?"

The origins of zero

The discovery of the concept of zero has been attributed to several different cultures. In addition to the Mayan Indians, credit has also been given to the Sumerians, the Hindu in

India, and Chinese. In the development of written notation, a symbol for zero evolved long after the symbols for other numbers were invented. Zero was not needed in primitive counting systems. There was no obvious need to express the absence of quantity (or nothing) or to have a character that would serve as a placeholder in writing larger numbers such as 101 or 2001. Consider the most primitive counting system, a hash mark on the ground, the wall of a cave, or on a stick. As the numbers increased, a system of grouping evolved. Think about keeping score in a card game, where we group our hash marks by fives – four hash marks and a diagonal line drawn though the four lines. This certainly makes it easy to count higher numbers because we can count the groups of five instead of large numbers of single hash marks. This works well up to a certain point, perhaps up to one hundred. To create a system for writing larger numbers, different symbols were created. The Romans developed a familiar system that we occasionally still see used to day, but has fallen out of use because some limitations. These are limitations that are solved by zero. Let's see how.

When I was citing the reference for the encyclopedia that I used as one of the references to this essay, I wanted to record the year in which the book was published. It was written in the inside cover in Roman numerals (a coincidence that offered a convenient example to use here!). The date of publication was MCMLXXI. OK, quickly, when was the encyclopedia published? This form of notation works for the display of large number, but it is cumbersome to read. Would not 1971 be easier to write and interpret than MCMLXXI? It has fewer characters, for one. Even more difficult, however, is manipulating numbers using Roman numerals. Try dividing MCMLXXI by four to find out if it is a leap year. Chances are, you would convert this to the ten-based Arabic system we now commonly use to make this calculation easier (if not possible at all!). Without Arabic numbers, it is a very difficult calculation.

What about negative numbers? The Greeks and Romans did not use negative numbers because they did not make sense to them. Consider this example: There are four people in a room. Seven people leave. How many are left? There is no notation for negative numbers or designating zero with Roman numerals – an important point to distinguish between negative and positive numbers and for other phenomena that require it.

Many authors credit the Babylonians with creating a placeholding symbol that evolved into zero in about 300 BC (or BCE for some of you!). The Babylonians had used mechanical counting devices, abacuses that worked by moving stones up and down in columns. They needed a way to document calculation permanently and used on clay tablets to record numbers. Their counting system was 60-based and columns were measured in groups of one, sixty and thirty-six hundred. Without a placeholder, the symbols for one, sixty and thirty-six hundred were the same. The Babylonians had no way to denote which column a symbol was in. To resolve this problem, a symbol was developed to represent an empty space. This placeholder symbol made it easy to tell which position a symbol was in. To relate the importance of this concept to the solving the shortcoming of Roman numerals, consider the following example. See how much easier it is to understand the Arabic number 1907 compared to the Roman numeral MCMVII? If we want to find out in what year a 45 year-old person was born, it is

considerably easier to make this calculation using a system where each "place" represents groups of 1's, 10's, 100's and 1000's that can be placed in columns, than a system that does not have "places" like Roman numerals. Seife states "Zero was born out of the need to give any given sequence of …digits a unique, permanent meaning. It did not yet have a numerical value of its own, however. It was a digit, not a number. It had no value.

The value of a number comes from a position compared to other numbers and a place on a number line. The number "one" does seem like a logical place to begin counting. This came to light in the evolution of the calendar, which is where the Mayan people of Mexico and Central America get involved. For them, starting to count at one did *not* make sense. They started numbering their days with the number zero. Each month had twenty days, but was numbered zero through nineteen, not one through twenty, as we would do. Using a system starting at zero, there would be no controversy over the start of the millennium. If we had started at zero, the second, thousand years would have ended at the conclusion of 1999 and the new millenium starting at the stroke of midnight, year 2000 as it was celebrated this past year. As noted in a previous Kit Kat essay, we have erroneously celebrated the new millenium a year prematurely. We started counting at one, not zero, and the millenium should really be celebrated at the end of *this* year. On a positive note, it should be easier and less expensive to do it properly this year compared to last! With the system we have chosen to use, there is also literally no year zero; time moved from 1 BC to 1 AD, resulting in a missing year.

More significant aspects of zero

In addition to the significance as a placeholder and starting point for the number scale, zero has been an important concept beyond mathematics throughout history. This has been reflected in philosophy, art and economics.

The primary reason why zero was rejected by Western cultures and not fully accepted until the 17th century began with the Greeks and Romans who hated zero. There were several reasons for this. For one, zero was linked to a void or nothingness. Greeks and Romans were logical people and feared void and chaos. They were highly developed in the use of mathematics, but as we have seen, found that zero did not behave logically. The example cited earlier was dividing by zero. It results in an "inadmissible operation." Archimedes stated that if you add something to itself enough times, it will exceed any other number in magnitude. This works for any number except zero (unless you do not consider zero a number!). Thus, zero undermines the simplest rules of mathematics. The Greek and Roman cultures did not acknowledge zero as a number or the concept of a void. The need to explain all things in rational terms fostered the idea that the earth was the center of the universe and that all things could be described in terms of relationships with numbers. Zero undermined this mentality.

Now consider the Biblical account of the Creation. "In the beginning when God created the heavens and earth, and the earth was a *formless void* and darkness covered the face of the deep while a wind from God swept over the face of the water."[9] and, "So God blessed the seventh day and hallowed it, because on it, God rested from all the work that

he had done in creation."[10] The concept of the void and nothingness needed to be reconciled within Western culture.

During medieval time, scholars branded zero, nothing, and a void as evil, and likewise evil as nothingness and a void. God was omnipotent. At this time, Christianity was closely tied to the Aristotelian view of the universe that rejected unexplainable concepts like the infinite and nothingness. As recently as 1600, Giordano Bruno was burned at the stake for publishing *On the Infinite Universe and Worlds*, where he suggested that the earth was not the center of the universe and that there were infinite worlds like our own. In 1616, Galileo was ordered by the church to cease his scientific investigations because they suggested unexplainable concepts. It took mathematicians and philosophers until the 17th century to become comfortable with unexplainable concepts such as zero, nothingness and void and begin thinking openly about creation and eternity. One person who helped this along was the astronomer Kepler, who was able to develop a simple and accurate model for showing that the planets, including the earth, moved in ellipses around the sun, rather than the earth being the center of the universe. Another mathematician-philosopher who helped break down belief in the philosophy of Aristotle was René Descartes, who developed the Cartesian coordinate system. In this system, a grid is used to measure the place of points, lines and shapes using vertical and horizontal lines that intersect at "the origin" – a point labeled (0,0). Zero was at the center of the coordinate system. Zero must be used to describe the geometric shapes using equations and the Cartesian coordinate grid system.

While most of us cannot comfortably describe the void that might have existed before creation or the infinite that followed, we no longer reject talking about it, and certainly have a concept of zero. Certainly no one is persecuted for discussing these concepts!

Zero was also late to appear in the world of art. Until the 1400's, western European art was painted without the benefit of understanding perspective. The Iconic art of this period appears flat and lifeless, with no depth. Each character appearing to "stand on each others feet." The discovery of the vanishing point, where all lines converge into a single point – into nothing or zero - was a breakthrough in Western art. Just as acceptance of zero opened the doors to fresh thinking in religion and philosophy, it was at the center of renaissance art in the form of the vanishing point. The Italian architect, Filippo Brunelleschi first demonstrated this power of an infinite zero. In 1425, Brunelleschi placed an infinitesimal dot on a canvas that represented a spot infinitely far from the viewer. He noted that as objects receded into the distance, they got closer to this point and more compressed. When Brunelleschi used a mirror to compare a painting using this principle, the reflected image matched the building's geometry exactly. The discovery of the vanishing point where all points converge to zero was a significant breakthrough in the visual arts and the ability to realistically portray an image.

Zero has also been important in economics. One of the first and most important breakthroughs in the history of commerce was the system of double entry and accounting sometime before 1340. This is a simple idea of totaling credits and debits on the same page in parallel columns. If the difference between the sums on each column is zero, the

books balance, showing the accounts are accurately kept. Profits generate positive numbers, familiar to all. Losses created the need for negative numbers, which came later and zero as the point that separates positive (profits) and negative (losses) numbers being born as a necessity. Roman numerals were used for a time with this system, but since there was no symbol for zero, they were gradually were replaced by the Arabic numbers we use today. Roman numerals were used primarily for dates and "putting a stamp of solemnity" on documents. Clearly, all financial record keeping systems rely on zero as their basis and adds to the significance of zero.

It has even been argued that the emergence of paper money is associated with the semiotics, or symbol of zero, because after the gold standard was abandoned, paper currency has only imaginary value. But, that's a topic for another essay (by someone else!)

Summary

Much ado about nothing? As we have seen, there is really something about zero for everyone and many among us – scientists, clergy, politicians, philosophers, bankers, astronomers and those in the arts. I suppose I could have called this essay "Much Ado About Everything." But, that would not have been a very clever title, would it?

Fred, you probably *did* know what kind of Pandora's box you opened three and a half years ago when you asked me the simple question "why is the discovery of zero significant?" It is truly an endless question (the reciprocal of zero). I hope I have provided a start to the answer (not zero!).

I look forward to your thoughts, perspectives and, if at all necessary, your questions.

Thank you.

REFERENCES

1. Kaplan, Robert. *The Nothing That Is – A Natural History of Zero.* Oxford University Press, New York. 1999.
2. Seife, Charles. *Zero – The Biography of a Dangerous Idea.* Viking, New York. 2000.
3. Darby, Jay. Hip 2 B^2. *Hemispheres*, 2000(October); 116-122.
4. www.biographycom/features/millennium/list.html
5. Rotman, Brian. Signifying Nothing – The Semiotics of Zero. Stanford University Press, Stanford CA. 1993.
6. *Webster's New Collegiate Dictionary*, G. & C. Mirriam Co., Springfield, MA. 1961:995.
7. Evans, Ivor H. *Brewer's Dictionary of Phrase and Fable.* 14th Edition. Harper Perennial, New York. 1991:1199.
8. Funk and Wagnall's New Encyclopedia, Volume 28; MCMLXXI(1971):150.
9. Genesis, chapter 1, verses 1 and 2. Holy Bible, New Revised Standard Version, Thomas Nelson Publishers, Nashville. 1989:1.
10. Genesis, chapter 2, verse 2. Holy Bible, New Revised Standard Version, Thomas Nelson Publishers, Nashville. 1989:2.

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