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A Brief Look at Mathematics and Theology

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Such a really remarkable discovery. I wanted your opinion on it. You know the formula m over naught equals infinity, m being any positive number? [m/0 = ∞]. Well, why not reduce the equation to a simpler form by multiplying both sides by naught? In which case you have m equals infinity times naught [m = ∞ x 0]. That is to say, a positive number is the product of zero and infinity. Doesn't that demonstrate the creation of the Universe by an infinite power out of nothing? Doesn't it?

Aldous Huxley, *Point Counter Point*
(1928), Chapter XI

INTRODUCTION

We are living in a mathematical age. Our lives, from the personal to the communal, from the communal to the international, from the biological and physical to the economic and even to the ethical, are increasingly mathematicized. Despite this, the average person has little necessity to deal with the mathematics on a conscious level. Mathematics permeates our world, often in "chipified" form. According to some theologies, God also permeates our world; God is its origin, its ultimate power, and its ultimate reason. Therefore it is appropriate to inquire what, if anything, is the perceived relationship between mathematics and God; how, over the millennia, this perception has changed; and what are its consequences.

I begin with two stories. Recently, I spread the word quite among my mathematical friends that I had been invited to lecture on mathematics and theology. I wanted to get a reaction, perhaps even a suggestion or two.

One, a research mathematician, the chairman of his department, who, in his personal life would be considered very devout in a traditional religious sense, told me that, "God could never get tenure in our department."

Another friend, well versed in the history of mathematics, told me, "The relation between God and mathematics simply doesn't interest me."

I think that these two reactions sum up fairly well the attitude of today's professional mathematicians. Though both God and mathematics are everywhere, mathematicians tend towards agnosticism; or, if religion plays a role in their personal lives, it is kept in a

separate compartment and seems not to be a source of professional inspiration.

There is hardly a book that deals in depth with the 4000 year history of the relationship between mathematics and theology. There are numerous articles and books that deal with particular chapters of the story. Ivor Grattan-Guinness has written on mathematics and ancient religions. Joan Richards has treated the influence of non-euclidean geometry in Victorian England. Joseph Davis and others have treated the attempts at the reconciliation of science and religion by Jewish scholars of the seventeenth century. But most historians of mathematics in the past two centuries, under the influence of the Enlightenment and of positivistic philosophies have avoided the topic like the plague.

This suppression has been an act of "intellectual cleansing" in the service of presenting mathematics as a pure logical creation, "undefiled" by contact with human emotions or religious feelings. It parallels the many acts of iconoclastic destruction that have overtaken civilization at various times and places and is still taking place. Why has it occurred? Numerous reasons have been suggested. Is it the Enlightenment and positivistic philosophies?

But things are now changing. The separation of mathematics and theology is now not nearly so rigid as it has been since, e.g., Laplace's day. There is now a substantial reversion in physics, biology, mathematics, etc to the older position. The material published runs from what is very thoughtful and sincere to what might be called "crazy." (And what is the test for what is and what is not "crazy"?).

Why? Is it part of the general perception that rationalism has its limitations? The current generation finds positivistic philosophies lacking in social and emotional warmth and in transcendental values. It is now trying to reclaim those values with syntheses of God, the Bible, Apocalyptic visions, the Nicene Creed, Zero, Infinity, Gödel's Theorem, Quantum Theory, the Omega Point, the God Particle, Chaos, Higher Dimensions, Multiple Universes, Neo-Pythagoreanism, Theories of Everything, etc. etc. I find that most of this is bizarre. When it comes to specific statements, such as "God is a mathematician", I find the discussions both pro and con unconvincing, but I would not say, as an older generation of positivists might have said, that the statement is meaningless.

The extent of the historic relationship between mathematics and theology should not be underestimated. There is much that can be and has been said. Practically every major theme of mathematics, its concepts, its methodology, its philosophy, have been linked in some way to theological concepts. Individual mathematical features such as number, geometry, pattern, computation, axiomatization, logic, deduction, proof, existence, uniqueness, non-contradiction, zero, infinity, randomness, chaos, entropy, fractals, self-reference, catastrophe theory, description, modeling, prediction, have been wide open for theological questions and answers.

As simple examples: is God constantly geometrizing? Does God have the power to make $2 + 2$ other than 4? Does God predict or simply know?

The links between mathematics and theology are part of the history of mathematics and part of the mathematical civilization into which we were born. They are part of applied mathematics. In recent years, these links have been extended to embrace theological relations to cognition, personhood, feminism, ethnicity.

The contributions of mathematics to theological thought have been substantial. The young John Henry Newman (1801-1890. Later: Cardinal) asserted that the statements of mathematics were more firm than those of dogmatic theology. Hermann Cohen, philosopher (1842 - 1918) thought that mathematics was the basis on which theology must be built. In many recent discussions, as we shall see, mathematics takes objective priority over theology just as it did to Cardinal Newman. On the other hand, one should remind oneself of the ascending hierarchical order in the days of the Scholastics (e.g., St. Thomas Aquinas, 1225-1274): mathematics, philosophy, metaphysics, with theology at the apex.

In the other direction, the contributions of theology and religious practice to mathematics were also substantial - at least until around the 14th Century. As examples church and astronomical (secular) calendars are mathematical arrangements and needed reconciliation. The Jewish philosopher and theologian Moses Maimonides (1135 - 1204) wrote a book entitled *On*

the Computation of the New Moon. Among Moslems, the determination of the qibla (the bearing from any spot towards Mecca) was important and fostered the development of spherical trigonometry. These various demands led to improved techniques and theories. Kim Plofker has only recently discussed the historical attempts to reconcile sacred and secular Indian cosmologies.

Astrology which very often had links to theology and religious practice, demanded exact planetary positions, and astrology stimulated and supported mathematics for long periods of time and led to intellectual controversy. Astrology carries with it an implication of rigid determinism and this came early into conflict with the doctrine of free will. The conflict was reconciled by asserting that though the stars at the time of one's nativity control one's fate, God has the final say, so that prayer, repentance, sacrifice, etc., undertaken as a free will impulse, can alter the astrological predictions. This is the message of Christian Astrology, two books with the same title written centuries apart by Pierre Dailly (1350-1420) and by William Lilly (c. 1647).

With the discrediting of astrology as a predictive technique (even as it remains a technique for individuals to shape their daily behavior), such contributions have certainly been much less publicized or emphasized in recent mathematical history than,, e.g., technological or military demands

On a much wider stage and at a deeper level, claims have been made and descriptions have been given of the manner in which Christian theology entered into the development of Western science. Here is the contemporary view of Freeman Dyson:

> Western science grew out of Christian theology. It is probably not an accident that modern science grew explosively in Christian Europe and left the rest of the world behind. A thousand years of theological disputes nurtured the habit of analytical thinking that could be applied to the analysis of natural phenomena. On the other hand, the close historical relations between theology and science have caused conflicts between science and Christianity that do not exist between science and other religions.... The common root of mod-

ern science and Christian theology was Greek philosophy.

The same claim might be asserted for mathematics, though perhaps with somewhat less strength.

A few western opinions over the ages, arranged more or less chronologically, should give us the flavor, if not the details, of the relationship between mathematics and theology. (See e.g., David King for Islamic writings, and David Pingree and Kim Plofker for Indian.)

However, while citing and quoting is a relatively easy matter, it is not easy to enter into the frame of mind of the authors quoted and of the civilizations of which they were part; how the particular way they expressed themselves mathematically entered into the whole. Thus Plofker has written:

> It is difficult to draw a clear and consistent picture of the opinions of authors who reject some assumptions of sacred cosmology while espousing others... To many scholars eager to validate the scientific achievements of medieval Indians according to modern criteria, the very notion of their deferring to scriptural authority [the Puranas] at all is something of an embarassment.

To appreciate this, it helps to remember that the secularization and the disenchantment (i.e., disbelief in ritual magic) of the world is a relatively recent event which occurred in the late seventeenth century. For an older discussion of this point, see W.E.H.Lecky.

To quote contemporary historian of mathematics Ivor Grattan-Guinness:

> Two deep and general points about ancient cultures are often underrated that people saw themselves as part of nature, and mathematics was central to life. These views stand in contrast to modern ones, in which nature is usually regarded as an external area for problem-solving, and mathematicians are often treated as mysterious outcasts, removed from polite intellectual life.

And David Berlinski, (contemporary, philosopher, and

science writer) writes:

> As the twenty-first century commences, we are largely unable to recapture the intensity of conviction that for all of western history has been associated with theological belief.

I now shall present numerous clips, mostly of older authors, organized according to certain mathematical topics.

Number

Perhaps the earliest mathematics/theology relationship is "number mysticism", the attribution of secret or mystic meanings of individual numbers and of their influence on human lives. This is often called numerology and its practice was widespread in very ancient times. Odd numbers are male. Even numbers are female. In Babylonia the numbers from I to 60 were associated with a variety of gods, and these characteristics are just for starters. Since alphabetic letters were used as numbers, the passage from numbers to ideas and vice versa was rich in possibilities.

"All is number," said Pythagoras (c. 550 BC), around whom a considerable religious cult formed and whose cultic practices seemed to involve mathematics in a substantial way. The historian of mathematics, Carl B. Boyer, wrote, "Never before or since has mathematics played so large a role in life and religion as it did among the Pythagoreans."

The words "or since" may be easily challenged without in the least denying the importance of mathematics for the Pythagorean Brotherhood.

Some mathematical mysticism occurs in Plato's Timaeus. There, Plato (c. 390 BC) takes the dodecahedron as a symbol for the whole Universe and says that: "God used it for the whole." For Plato, the world has a soul and God speaks through mathematics.

Ideas of number mysticism spread from Pagan to Christian thought. The Revelations of John (c. end of 1st Century) is full of numbers and of number mysticism. For example:

> Here is the secret meaning of the seven stars which you saw in my right hand and of the seven lamps of gold: the seven stars are the angels of the seven churches, and the seven lamps are the seven churches. (Rev. 1:20).

And then, there is the famous, oft quoted passage in Revelations 13:18:

> ...anyone who has intelligence may work out the number of the Beast. The number represents a man's name and the numerical value of its letters is six hundred and sixty six.

Innumerable computations of the Second Coming, or of the Days of the Messiah have been carried out. The idea that the end of the world can be computed is very old.

The Apocalypse, foretold in Revelations, and said to precede the Second Coming, has been and still is a favorite subject for mathematical speculation and prediction. The predictions are usually made along arithmetic lines and make use of some method of giving numbers to the historic years. For the details of a computation of the date of the Apocalypse carried out by John Napier (15 50 - 1617), the creator of logarithms and one of the leading mathematicians of his day, the reader is referred to the splendid book of Katharine Firth.

Religious authorities have often proscribed such computations. But such computations have never disappeared and the desire to calculate the end of days is present in contemporary end-of-the-world cosmologies based on current astrophysical knowledge as well as in tragic episodes of religious fundamentalism.

Iamblichus (c. 250 - 330), a Neo-Platonist, in his *Theologoumena tes Arithmetikes* (The Theology of Arithmetic) explains the divine aspect of each of the numbers from one up to ten.

St. Augustine (354 - 430) asserted that the world was created in six days because six is a perfect number (i.e., a number equal to the sum of its divisors). Augustine also said: Numbers are the link between humans and God. They are innate in our brains.

In the 12th Century, the Neoplatonist Thierry of Chartres opined: "The creation of number was the creation of things."

The colorful mathematician and physician Geronimo Cardano (1501 - 1576) cast a horoscope for Jesus and earned thereby the wrath of the hierarchy.

The humanistic Shakespeare, whose works display little religious sentiment, has a line: "There is divinity in odd numbers." Was he perhaps picking up on the Trinity and the mystic number 3 ?

Blaise Pascal (1623 -1662), an early figure in the development of probability theory, "proves" the existence of God by means of a wager:

> God is or He is not. Let us weigh the gain and the loss in selecting 'God is.' If you win, you win all. If you lose, you lose nothing. Therefore bet unhesitatingly that He is. —Pensees.

"Pascal's Wager" has generated a vast literature of its own.

Sir Isaac Newton, convert to (heretic) Arianism, alchemist, theologian, (1642 - 1727), the "last of the magicians" according to John Maynard Keynes, is so preeminent in mathematics and physics that the amount of material on his "nonscientific" writings—for long considered by historians of science to be an aberration—is now substantial. See, e.g., James E. Force and Richard Popkin and also B.J.T Dobbs. Briefly, Newton attempted to combine mathematics and astronomical science so as to prepare a revised chronology of world history and thereby to understand the divine message. For example, we find in Newton's *The Chronology of Ancient Kingdoms Amended*:

> Hesiod tells us that sixty says after the winter solstice, the star Arcturus rose just at sunset: and thence it follows that Hesiod flourished about a hundred years after the death of Solomon, or in the Generation or Age next after the Trojan War, as Hesiod himself declares.

Also,

> Newton saw his scientific work as evidence of God's handiwork. He turned to religious studies later in life and considered it an integral part of his thinking. Indeed, just as today's cosmologists are trying to find a 'Theory of

Everything' , Newton looked for a unification of the sacred texts with his mathematico-physical theories. —Katz & Popkin.

In mathematician and clergyman John Craig's "Mathematical Principles of Christian Theology" (1699), Craig calculated, based on an observed decline in belief and a passage in St. Luke, that the second coming would occur before the year 3150. To a contemporary mathematician, Craig's reasoning is not unlike an argument from exponential decay.

Expressions of number mysticism ebb and flow. They seem never to disappear entirely. Today, number mysticism is widespread. There are said to be lucky and unlucky numbers - an ancient idea. These selections, intended for personal use, are widely available in books and newspapers." Your number for the day is 859." "In the year 1000 or 1666 or 2000 something good or something bad will happen." The question of whether these kinds of assertions are "deeply believed" is often irrelevant given the extent to which its practice results in human actions.

Recently there were various to-dos about the new "Millennium", (including a billion-pound exhibition in London) as though the year 2000 inherited mystic properties from its digital structure. In the "Y2K flap", digital programming was indeed important, but the excessive publicity and mild hysteria were hallmarks of a virulent attack of number mysticism.

The spirit of Pythagoras seems to have influenced the thought of a number of distinguished 20th Century physicists. Arthur Eddington (1882-1944) and P.A.M. Dirac (1902-1984), for example, have searched for simple whole number (i.e., integer) relationships between the fundamental physical constants expressed nondimensionally. Then, seemingly denying simplicity, Dirac wrote, "God is a mathematician of a very high order. He used some very advanced mathematics in constructing the Universe."

The number of amazing patterns that can be constructed via simple arithmetic operations is endless, and to each pattern can be attributed mystic potency or divine origin. Ivor Grattan-Guinness, who is also a musician and musicologist, in a section on "the power of number" in his *History of the Mathematical Sciences*, gives instances involving Kepler, Newton, Freema-

sonry, and Bach, Mozart, and Beethoven. About W.A. Mozart (175 6-9 1), he says in part:

> Mozart's opera *The Magic Flute*, written in 1791, to defend Masonic ideals against political attack, is crammed with numerology and some gematria. [Gematria = the identification of letters with numbers and used to arrive at insights].

But number, though operating within a theological context, is not always conceived within a mystic theology though we may now think otherwise. Thus Leibniz (1646-1716), "Cum Deus calculat et cogitationem exercet, fit mundus." (When God thinks things through and calculates, the world is made.)

Today, we may omit "Deus" from this precept: via calculation we create everything from huge arches in St. Louis (which has a great spiritual quality), to designer drugs or to the human genome map project. To some people, these numerical computations provide the latest answer to the Biblical question, "What is man that thou are mindful of him; the son of man that thou shouldst visit him?" (Ps. 8,4) without answering in the least what the long-range effects of such computations will be.

Thus, numbers. All of the instances cited, together with those that follow in later sections, may be deemed "applied mathematics", for they apply mathematics to human concerns and not to mathematics itself. Such an expanded meaning would be in strong disagreement with the current usage of "applied mathematics."

Geometry; Space

We find in the Old Testament, Proverbs 8:27: "He girded the ocean with the horizon." The Hebrew word for gird is "chug." A mathematical compass is a "mechugah." Same root. God compasses the world.

The image of God as the one who wields the compass was common. The Renaissance artists liked it and drew it over and over. In Amos Funkenstein's splendid *Theology and the Scientific Imagination*, you will find that on his cover there is a mediaeval picture showing Christ measuring the world with a compass. The compass motif lasted well into the 18th century when William Blake (1757-1827, mystic artist and poet) pro-

duced a famous engraving that combined these elements. Was this merely artistic metaphor, or was it stronger?

The world, therefore, was constructed geometrically. The classic statement is "God always geometrizes."

On a much more abstract level, Moses Maimonides (1135-1204, philosopher, theologian, and physician) denied the infinity of space. In this regard, he sided with Aristotle. On the other hand, Hasdai Crescas, poet and philosopher, (1340 - 1410) allowed it.

In Art: Dilrer (1471 - 1528), Michaelangelo (1475 - 1564), and numerous other artists of the period, men who were well versed in the mathematics of the day, looked for the divine formula that would give the proportions of the human body. The human body was God's creation and perfection must be found there. This perfection was thought to be expressible through mathematical proportions.

Hermetic geometry (i.e., geometrical arrangements that were thought to embody occult or religious forces) abounded. Churches were constructed in the form of the cross. Secular architecture was not free of it: the Castel del Monte erected for Frederick II Hohenstaufen (1194 -1250), by Cistercian monks, displays an intricate geometrical arrangement, a fusion of European and Arabic sensibilities, based on the octagon and whose plan has been said to symbolize the unity of the secular and the sacred.

In the *Monas Hieroglyphica* (heiros, Greek: sacred, supernatural) of John Dee (1564), mathematician, the first translator of Euclid into English a man who was both a rationalist, an alchemist, and a crystal-ball gazer, delineates certain assemblages of figures that have potency deriving from a mixture of their geometrical/astral/theological aspects.

Consider next the spiral. Much has been written about its symbolism: in mathematics, in astronomy, in botany, in shells, and animal life, in art, architecture, decoration, in Jungian psychology, in mysticism, in religion. To the famous Swiss mathematician Johann Bernoulli (1667 - 1748) who created the mathematically omnipresent Spiral of Bernoulli, its self-reproducing properties suggested it as a symbol of the Resurrection, and he had its figure carved on his grave-

stone in Basle. Today, the double helix carries both a biological meaning as well as an intimation of human destiny.

In my childhood, the circle persisted as a potent magic figure in the playtime doggerel "Make a magic circle and sign it with a dot." The interested reader will find thousands of allusions to the phrase "magic circle" on the Web. Magic ellipses or rectangles are less frequent.

The Buddhist mandalas which are objects of spiritual contemplation, embody highly stylized geometrical arrangements. The amulets and talismans that are worn on the body, placed on walls, displayed in cars; the ankhs, the crosses, the hexagrams, the outlined fish, the horseshoes, the triangular abracadabra arrangements and magical squares, the sigils (magical signs or images) of which whole dictionaries were compiled in the 17th century, the hex signs placed on house exteriors, all point to geometry in the service of religious or quasi-religious practice.

There is a multitude of geometrical figures signs employed in kabbalistic practices, each associated with stars, planets, metals, stones, spirits, demons, and whose mode of production and use is specified rigorously. Wallis Budge, student of Near Eastern antiquities wrote:

> According to Cornelius Agrippa [physician and magician, 1486 - 1535], it is necessary to be careful when using a magical square as an amulet, that it is drawn when the sun or moon or the planet is exhibiting a benevolent aspect, for otherwise the amulet will bring misfortune

and calamity upon the wearer instead of prosperity and happiness.

Let semanticists and semioticists explain the relationship between our geometrical symbols and our psyches for it lies deeper than simple designation (e.g., crescent = Islam). The geometrical swastika, which over the millennia and cultures has carried different interpretations, is now held in abhorrence by most Americans. The memory of World War II is certainly at work here, but the geometry can go "abstract" and its meaning become detached from an original historic context.

Why has Salvador Dali (1904 - 1989) in his large painting Corpus Hypercubus in the Metropolitan Museum in New York, placed a crucifixion against a representation of a four dimensional cube? Art historian Martin Kemp has commented:

> Dali's painting does stand effectively for an age-old striving in art, theology, mathematics, and cosmology for access to those dimensions that lie beyond the visual and tactile scope of the finite spaces of up-and-down, left and right, and in-and-out that imprison our common sense perceptions of the physical world we inhabit. The scientists' success in colonizing the extra dimensions is defined mathematically...

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To be continued...The remainder of this article, including bibliography and notes will be issued online in HMNJ #27.

Pat's Prologues

Introductions to the First Two Airings of Math Medley, A Radio Talk Show

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Since May 1998 I've been hosting a weekly radio call-in talk show, "Math Medley." It appears to be the first of its kind, according to both the math and the radio grapevines. Each week I interview someone about "education, parenting, equity, and environmental issues with an underlying theme of mathematics," to

quote my opening patter.

It's been a joyous foray into show biz for a math professor. Everything is done by telephone—to and from anywhere! Some of my guests are experienced radio hams, but many are appearing for the first time. All