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Number: Its Origin and Evolution

The wrenching and demoralizing character of the crisis we find ourselves in, above all, the growing emptiness of spirit and artificiality of matter, lead us more and to question the most commonplace of "givens." Time and language begin to arouse suspicions; number, too, no longer seems "neutral." The glare of alienation in technological civilization is too painfully bright to hide its essence now, and mathematics is the schema of technology.

It is also the language of science—how deep we must go, how far back to reveal the "reason" for damaged life? The tangled skein of unnecessary suffering, the strands of domination, are unavoidably being unreeled, by the pressure of an unrelenting present.

When we ask, to what sorts of questions is the answer a number, and try to focus on the meaning or the reasons for the emergence of the quantitative, we are once again looking at a decisive moment of our estrangement from natural being.

Number, like language, is always saying what it cannot say. As the root of a certain kind of logic or method, mathematics is not merely a tool but a goal of scientific knowledge: to be perfectly exact, perfectly self-consistent, and perfectly general. Never mind that the world is inexact, interrelated, and specific, that no one has ever seen leaves, trees, clouds,animals, that are two the same, just as no two moments are identical. As Dingle said, "All that can come from the ultimate scientific analysis of the material world is a set of numbers," reflecting upon the primacy of the concept of identity in math and its offspring, science.

A little further on I will attempt an "anthropology" of numbers and explore its social embeddedness. Horkheimer and Adorno point to the basis of the disease: "Even the deductive form of science reflects hierarchy and coercion . . . the whole logical order, dependency, progression, and union of [its] concepts is grounded in the corresponding conditions of social reality" —that is, the division of labor.

If mathematical reality is the purely formal structure of normative or standardizing measure (and later, science), the first thing to be measured at all was time. The primal connection between time and number becomes immediately evident. Authority, first objectified as time, becomes rigidified by the gradually mathematized consciousness of time. Put slightly differently, time is a measure and exists as a reification or materiality thanks to the introduction of measure.

The importance of symbolization should also be noted, in passing, for a further interrelation consists of the fact that while the basic feature of all measurement is symbolic representation, the creation of a symbolic world is the condition of the existence of time.

To realize that representation begins with language, actualized in the creation of a reproducible formal structure, is already to apprehend the fundamental tie between language and number. An impoverished present renders it easy to see, as language becomes more impoverished, that math is simply the most reduced and drained language. The ultimate step in formalizing a language is to transform it into mathematics; conversely, the closer language comes to the dense concretions of reality, the less abstract and exact it can be.

The symbolizing of life and meaning is at its most versatile in language, which, in Wittgenstein's later view, virtually constitutes the world. Further, language, based as it is on a symbolic faculty for conventional and arbitrary equivalences, finds in the symbolism of math its greatest refinement. Mathematics, as judged by Max Black, is the "grammar of all symbolic systems."

The purpose of the mathematical aspect of language and concept is the more complete isolation of the concept from the senses. Math is the paradigm of abstract thought for the same reason that Levy termed pure mathematics "the method of isolation raised to a fine art." Closely related are its character of "enormous generality," as discussed by Parsons, its refusal of limitations on said generality, as formulated by Whitehead.

This abstracting process and its formal, general results provide a content that seems to be completely detached from the thinking individual; the user of a mathematical system and his/her values do not enter into the system. The Hegelian idea of the autonomy of alienated activity finds a perfect application with mathematics; it has its own laws of growth, its own dialectic, and stands over the individual as a separate power. Self-existent time and the first distancing of humanity from nature, it must be preliminarily added, began to emerge when we first began to count. Domination of nature, and then, of humans is thus enabled.

In abstraction is the truth of Heyting's conclusion that "the characteristic of mathematical thought is that it does not convey truth about the external world." Its essential attitude toward the whole colorful movement of life is summed up by, "Put this and that equal to that and this!" Abstraction and equivalence of identity are inseparable; the suppression of the world's richness which is paramount in identity brought Adorno to the "primal world of ideology." The untruth of identity is simply that the concept does not exhaust the thing conceived.

Mathematics is reified, ritualized thought, the virtual abandonment of thinking. Foucalt found that "in the first gesture of the first mathematician one saw the constitution of an ideality that has been deployed throughout history and has questioned only to be repeated and purified."

Number is the most momentous idea in the history of human nature. Numbering or counting (and measurement, the process of assigning numbers to represent qualities) gradually consolidated plurality into quantification, and thereby produced the homogenous and abstract character of number, which made mathematics possible. From its inception in elementary forms of counting (beginning with a binary division and proceeding to the use of fingers and toes as bases) to the

Greek idealization of number, an increasingly abstract type of thinking developed, paralleling the maturation of the time concept. As William James put it, "the intellectual life of man consists almost wholly in his substitution of a conceptual order for the perceptual order in which his experience originally comes."

Boas concluded that "counting does not become necessary until objects are considered in such generalized form that their individualities are entirely lost sight of." In the growth of civilization we have learned to use increasingly abstract signs to point at increasingly abstract referents. On the other hand, prehistoric languages had a plethora of terms for the touched and felt, while very often having no number words beyond *one*, *two* and *many*. Hunter-gatherer humanity had little if any need for numbers, which is the reason Hallpike declared that "we cannot expect to find that an operational grasp of quantification will be a cultural norm in many primitive societies." Much earlier, and more crudely, Allier referred to "the repugnance felt by uncivilized men towards any genuine intellectual effort, more particularly towards arithmetic."

In fact, on the long road toward abstraction, from an intuitive sense of amount to the use of different sets of number words for counting different kinds of things, along to fully abstract number, there was an immense resistance, as if the objectification involved was somehow seen for what it was. This seems less implausible in light of the striking, unitary beauty of tools of our ancestors half a million years ago, in which the immediate artistic and technical (for want of better words) touch is so evident, and by "recent studies which have demonstrated the existence, some 300,000 years ago, of mental ability equivalent to modern man," in the words of British archeologist Clive Gamble.

Based on observations of surviving tribal peoples, it is apparent, to provide another case in point, that hunter-gatherers possessed an enormous and intimate understanding of the nature and ecology of their local places, quite sufficient to have inaugurated agriculture perhaps hundreds of thousands of years before the Neolithic revolution. But a new kind of relationship to nature was involved; one that was evidently refused for so many, many generations.

To us it has seemed a great advantage to abstract from the natural relationship of things, whereas in the vast Stone Age being was apprehended and valued as a whole, not in terms of separable attributes. Today, as ever, when a large family sits down to dinner and it is noticed that someone is missing, this is not accomplished by counting. Or when a hut was built in prehistoric times, the number of required posts was not specified or counted, rather they were inherent to the idea of the hut, intrinsically involved in it. (Even in early agriculture, the loss of a herd animal could be detected not by counting but by missing a particular face or characteristic features; it seems clear, however, as Bryan Morgan argues, that "man's first use for a number system" was certainly as a control of domesticated flock animals, as wild creatures became products to be harvested.) In distancing and separation lies the heart of mathematics: the discursive reduction of patterns, states and relationships which we initially perceived as wholes.

In the birth of controls aimed at control of what is free and unordered, crystallized by early counting, we see a new attitude toward the world. If naming is a distancing, a mastery, so too is number, which is impoverished naming. Though numbering is a corollary of language, it is the signature of a critical breakthrough of alienation. The root meanings of number are instructive: "quick to grasp or take" and "to take, especially to steal," also "taken, seized, hence . . . numb." What is made an object of domination is thereby reified, becomes numb.

For hundreds of thousands of years hunter-gatherers enjoyed a direct, unimpaired access to the raw materials needed for survival. Work was not divided nor did private property exist. Dorothy Lee focused on a surviving example from Oceania, finding that none of the Trobrianders' activities are fitted into a linear, divisible line. "There is no job, no labor, no drudgery which finds its reward outside the act." Equally important is the "prodigality," "the liberal customs for which hunters are properly famous," "their inclination to make a feast of everything on hand," according to Sahlins.

Sharing and counting or exchange are, of course, relative opposites. Where articles are made, animals killed or plants collected for domestic use and not for exchange, there is no demand for standardized numbers or measurements. Measuring and weighing possessions develops later, along with the measurement and definition of property rights and duties to authority. Isaac locates a decisive shift toward standardization of tools and language in the Upper Paleolithic period, the last stage of hunter-gatherer humanity. Numbers and less abstract units of measurement derive, as noted above, from the equalization of differences. Earliest exchange, which is the same as earliest division of labor, was indeterminate and defied systematization; a table of equivalences cannot really be formulated. As the predominance of the gift gave way to the progress of exchange and division of labor, the universal interchangeability of mathematics finds its concrete expression. What comes to be fixed as a principle of equal justice—the ideology of equivalent exchange—is only the practice of the domination of division of labor. Lack of a directly-lived existence, the loss of autonomy that accompany separation from nature are the concomitants of the effective power of specialists.

Mauss stated that exchange can be defined only by all the institutions of society. Decades later Belshaw grasped division of labor as not merely a segment of society but the whole of it. Likewise sweeping, but realistic, is the conclusion that a world without exchange or fractionalized endeavor would be a world without number.

Clastres, and Childe among others well before him, realized that people's ability to produce a surplus, the basis of exchange, does not necessarily mean that they decide to do so. Concerning the nonetheless persistent view that only mental/cultural deficiency accounts for the absence of surplus, "nothing is more mistaken," judged Clastres. For Sahlins, "Stone Age economics" was "intrinsically an anti-surplus system," using the term system extremely loosely. For long ages humans had no desire for the dubious compensations attendant on assuming a divided life, just as they had no interest in number. Piling up a surplus of anything was unknown, apparently, before Neanderthal times passed to the Cro-Magnon; extensive trade contracts were nonexistent in the earlier period, becoming common thereafter with Cro-Magnon society.

Surplus was fully developed only with agriculture, and characteristically the chief technical advancement of Neolithic life was the perfection of the container: jars, bins, granaries and the like. This development also gives concrete form to a burgeoning tendency toward spatialization, the sublimation of an increasingly autonomous dimension of time into spatial forms. Abstraction, perhaps the first spatialization, was the first compensation for the deprivation caused by the sense of time. Spatialization was greatly refined with number and geometry. Ricoeur notes that "Infinity is discovered . . . in the form of the idealization of magnitudes, of measures, of numbers, figures," to carry this still further. This quest for unrestricted spatiality is part and parcel of the abstract march of mathematics. So then is the feeling of being freed from the world, from finitude that Hannah Arendt described in mathematics.

Mathematical principles and their component numbers and figures seem to exemplify a timelessness which is possibly their deepest character. Hermann Weyl, in attempting to sum up (no pun intended) the "life sum of mathematics," termed it the science of the infinite. How better to express an escape from reified time than by making it limitlessly subservient to space—in the form of math.

Spatialization—like math—rests upon separation; inherent in it are division and an organization of that division. The division of time into parts (which seems to have been the earliest counting or measuring) is itself spatial. Time has always been measured in such terms as the movement of the earth or moon, or the hands of a clock. The first time indications were not numerical but concrete, as with all earliest counting. Yet, as we know, a number system, paralleling time, becomes a separate, invariable principle. The separations in social life—most fundamentally, division of labor—seem alone able to account for the growth of estranging conceptualization.

In fact, two critical mathematical inventions, zero and the place system, may serve as cultural evidence of division of labor. Zero and the place system, or position, emerged independently, "against considerable psychological resistance," in the Mayan and Hindu civilizations. Mayan division of labor, accompanied by enormous social stratification (not to mention a notorious obsession with time, and large-scale human sacrifice at the hands of a powerful priest class), is a vividly documented fact, while the division of labor reflected in the Indian caste system was "the most complex that the world had seen before the Industrial Revolution." (Coon 1954)

The necessity of work (Marx) and the necessity of repression (Freud) amount to the same thing: civilization. These false commandments turned humanity away from nature and account for history as a "steadily lengthening chronicle of mass neurosis." (Turner 1980) Freud credits scientific/mathematical achievement as the highest moment of civilization, and this seems valid as a function of its symbolic nature. "The neurotic process is the price we pay for our most precious human heritage, namely our ability to represent experience and communicate our thoughts by means of symbols."

The triad of symbolization, work and repression finds its operating principle in division of labor. This is why so little progress was made in accepting numerical values until the huge increase in division of labor of the Neolithic revolution: from the gathering of food to its actual production. With that massive changeover mathematics became fully grounded and necessary. Indeed it became more a category of existence than a mere instrumentality.

The fifth century B.C. historian Herodotus attributed the origin of mathematics to the Egyptian king Sesostris (1300 B.C.), who needed to measure land for tax purposes. Systematized math—in this case geometry, which literally means "land measuring"—did in fact arise from the requirements of political economy, though it predates Sesostris' Egypt by perhaps 2000 years. The food surplus of Neolithic civilization made possible the emergence of specialized classes of priests and administrators which by about 3200 B.C. had produced the alphabet, mathematics, writing and the calendar. In Sumer the first mathematical computations appeared, between 3500 and 3000 B.C., in the form of inventories, deeds of sale, contracts, and the attendant unit prices, units purchased, interest payments, etc.. As Bernal points out, "mathematics, or at least arithmetic, came even before writing." The number symbols are most probably older than any other elements of the most ancient forms of writing.

At this point domination of nature and humanity are signaled not only by math and writing, but also by the walled, grain-stocked city, along with warfare and human slavery. "Social labor" (division of labor), the coerced coordination of several workers at once, is thwarted by the old, personal measures; lengths, weights, volumes must be standardized. In this standardization, one of the hallmarks of civilization, mathematical exactitude and specialized skill go hand in hand. Math and specialization, requiring each other, developed apace and math became itself a specialty. The great trade routes, expressing the triumph of division of labor, diffused the new, sophisticated techniques of counting, measurement, and calculation.

In Babylon, merchant-mathematicians contrived a comprehensive arithmetic between 3000 and 2500 B.C., which system "was fully articulated as an abstract computational science by about 2000 B.C.. (Brainerd 1979) In succeeding centuries the Babylonians even invented a symbolic algebra, though Babylonian-Egyptian math has been generally regarded as extremely trial-and-error or empiricist compared to that of the much later Greeks.

To the Egyptians and Babylonians mathematical figures had concrete referents: algebra was an aid to commercial transactions, a rectangle was a piece of land of a particular shape. The Greeks, however, were explicit in asserting that geometry deals with abstractions, and this development reflects an extreme form of division of labor and social stratification. Unlike Egyptian or Babylonian society, in Greece, a large slave class performed all productive labor, technical as well as unskilled, such that the ruling class milieu that included mathematicians disdained practical pursuits or applications.

Pythagoras, more or less the founder of Greek mathematics (6^{th} century, B.C.) expressed this rarefied, abstract bent in no uncertain terms. To him numbers were immutable and eternal. Directly anticipating Platonic idealism, he declared that numbers were the intelligible key to the universe. Usually encapsulated as "everything is number," the Pythagorean philosophy held that numbers exist in a literal sense and are quite literally all that does exist.

This form of mathematical philosophy, with the extremity of its search for harmony and order, may be seen as a deep fear of contradiction or chaos, an oblique acknowledgement of the massive and perhaps unstable repression underlying Greek society. An artificial intellectual life that rested so completely on the surplus created by slaves was at pains to deny the senses, the emotions and the real world. Greek sculpture is another example, in its abstract, ideological conformations, devoid of feeling or their histories. Its figures are standardized idealizations; the parallel with a highly exaggerated cult of mathematics is manifest.

The independent existence of ideas, which is Plato's fundamental premise, is directly derived from Pythagoras, just as his whole theory of ideas flows from the special character of mathematics. Geometry is properly an exercise of disembodied intellect, Plato taught, in character with his view that reality is a world of form from which matter, in every important respect, is banished. Philosophical idealism was thus established out of this world-denying impoverishment, based on the primacy of quantitative thinking. As C.I. Lewis observed, "from Plato to the present day, all the major epistemological theories have been dominated by, or formulated in the light of , accompanying conceptions of mathematics."

It is no less accidental that Plato wrote, "Let only geometers enter," over the door to his Academy, than that his totalitarian *Republic* insists that years of mathematical training are necessary to correctly approach the most important political and ethical questions. Consistently, he denied that a stateless society ever existed, identifying such a concept with that of a "state of swine."

Systematized by Euclid in the third century B.C., about a century after Plato, mathematics reached an apogee not to be matched for almost two millennia; the patron saint of intellect for the slave-based and feudal societies that followed was not Plato, but Aristotle, who criticized the former's Pythagorean reduction of science to mathematics.

The long non-development of math, which lasted virtually until the end of Renaissance, remains something of a mystery. But growing trade began to revive the art of the quantitative by the twelfth and thirteenth centuries. The impersonal order of the counting house in the new mercantile capitalism exemplified a renewed concentration on abstract measurement. Mumford stresses the mathematical prerequisite of later mechanization and standardization; in the rising merchant world, "counting numbers began here and in the end numbers alone counted." (Mumford 1967)

But the Renaissance conviction that mathematics should be applicable to all the arts (not to mention such earlier and atypical forerunners as Roger Bacon's 13th century contribution toward a strictly mathematical optics), was a mild prelude to the magnitude of number's triumph in the seventeenth century.

Though they were soon eclipsed by other advances of the 1600's, Johannes Kepler and Francis Bacon revealed its two most important and closely related aspects early in the century. Kepler, who completed the Copernican transition to the heliocentric model, saw the real world as composed of quantitative differences only; its differences are strictly those of number. Bacon, in *The New Atlantis* (c.1620) depicted an idealized scientific community, the main object of which was domination of nature; as Jaspers put it, "Mastery of nature . . . 'knowledge is power,' has been the watchword since Bacon."

The century of Galileo and Descartes—pre-eminent among those who deepened all the previous forms of quantitative alienation and thus sketched a technological future—began with a qualitative leap in the division of labor. Franz Borkenau provided the key as to why a profound change in the Western world-view took place in the seventeenth century, a movement to a fundamentally mathematical-mechanistic outlook. According to Borkenau, a great extension of division of labor, occurring from about 1600, introduced the novel notion of abstract work. This reification of human activity proved pivotal.

Along with degradation of work, the clock is the basis of modern life, equally "scientific" in its reduction of life to a measurability, via objective, commodified units of time. The increasingly accurate and ubiquitous clock reached a real domination in the seventeenth century, as, correspondingly, "the champions of the new sciences manifested an avid interest in horological matters."

Thus it seems fitting to introduce Galileo in terms of just this strong interest in the measurement of time; his invention of the first mechanical clock based on the principle of the pendulum was likewise a fitting capstone to his long career. As increasingly objectified or reified time reflects, at perhaps the deepest level, an increasingly alienated social world, Galileo's principal aim was the reduction of the world to an object of mathematical dissection.

Writing a few years before World War II and Auschwitz, Husserl located the roots of the contemporary crisis in this objectifying reduction and identified Galileo as its main progenitor. The life-world has been "devalued" by science precisely insofar as the "mathematization of nature" initiated by Gallo has proceeded—clearly no small indictment. (Husserl 1970)

For Galileo as with Kepler, mathematics was the "root grammar of the new philosophical discourse that constituted modern scientific method." He enunciated the principle, "to measure what is measurable and try to render what is not so yet." Thus he resurrected the Pythagorean-Platonic substitution of a world of abstract mathematical relations for the real world and its method of absolute renunciation of the senses' claim to know reality. Observing this turning away from quality to quantity, this plunge into a shadow-world of abstractions, Husserl concluded that modern, mathematical science prevents us from knowing life as it is. And the rise of science has fueled ever more specialized knowledge, that stunning and imprisoning progression so well-known by now.

Collingwood called Galileo "the true father of modern science" for the success of his dictum that the book of nature "is written in mathematical language" and its corollary that therefore "mathematics is the language of science." Due to this separation from nature, Gillispie evaluated, "After Galileo, science could no longer be humane."

It seems very fitting that the mathematician who synthesized geometry and algebra to form analytic geometry (1637) and who, with Pascal, is credited with inventing calculus, should have shaped Galilean mathematicism into a new system of thinking. The thesis that the world is organized in such a way that there is a total break between people and the natural world, contrived as a total and triumphant world-view, is the basis for Descartes' renown as the founder of modern philosophy. The foundation of his new system, the famous "cogito ergo sum," is the assigning of scientific certainty to separation between mind and the rest of reality.

This dualism provided an alienated means for seeing only a completely objectified nature. In the *Discourse on Method*. . . Descartes declared that the aim of science is "to make us as masters and possessors of nature." Though he was a devout Christian, Descartes renewed the distancing from life that an already fading God could no longer effectively legitimize. As Christianity weakened, a new central ideology of estrangement came forth, this one guaranteeing order and domination based on mathematical precision.

To Descartes the material universe was a machine and nothing more, just as animals "indeed are nothing else but engines, or matter sent into a continual and orderly motion." He saw the cosmos itself as a giant clockwork just when the illusion that time is a separate, autonomous process was taking hold. Also as living, animate nature died, dead, inanimate money became endowed with life, as capital and the market assumed the attributes of organic processes and cycles. Lastly, Descartes mathematical vision eliminated any messy, chaotic or alive elements and ushered in an attendant mechanical world-view that was coincidental with a tendency toward central government controls and concentration of power in the form of the modern nation-state. "The rationalization of administration and of the natural order were occurring simultaneously," in the words of Merchant. The total order of math and its mechanical philosophy of reality proved irresistible; by the time of Descartes' death in 1650 it had become virtually the official framework of thought throughout Europe.

Leibniz, a near-contemporary, refined and extended the work of Descartes; the "pre-established harmony" he saw in existence is likewise Pythagorean in lineage. This mathematical harmony, which Leibniz illustrated by reference to two independent clocks, recalls his dictum, "There is nothing that evades number." Leibniz, like Galileo and Descartes, was deeply interested in the design of clocks.

In the binary arithmetic he devised, an image of creation was evoked; he imagined that one represented God and zero the void, that unity and zero expressed all numbers and all creation. He sought to mechanize thought by means of a formal calculus, a project which he too sanguinely expected would be completed in five years. This undertaking was to provide all the answers, including those to questions of morality and metaphysics. Despite this ill-fated effort, Leibniz was perhaps the first to base a theory of math on the fact that it is a universal symbolic language; he was certainly the "first great modern thinker to have a clear insight into the true character of mathematical symbolism."

Furthering the quantitative model of reality was the English royalist Hobbes, who reduced the human soul, will, brain, and appetites to matter in mechanical motion, thus contributing directly to the current conception of thinking as the "output" of the brain as computer.

The complete objectification of time, so much with us today, was achieved by Issac Newton, who mapped the workings of the Galilean-Cartesian clockwork universe. Product of the severely repressed Puritan outlook, which focused on sublimating sexual energy into brutalizing labor, Newton spoke of absolute time, "flowing equably without regard to anything external." Born in 1642, the year of Galileo's death, Newton capped the Scientific Revolution of the seventeenth century by developing a complete mathematical formulation of nature as a perfect machine, a perfect clock.

Whitehead judged that "the history of seventeenth-century science reads as though it were vivid dream of Plato or Pythagoras," noting the astonishingly refined mode of its quantitative thought. Again the correspondence with a jump in division of labor is worth pointing out; as Hill described mid-seventeenth century England, ". . . significant specialization began to set in. The last polymaths were dying out . . ." The songs and dances of the peasants slowly died, and in a rather literal mathematization, the common lands were closed and divided.

Knowledge of nature was part of philosophy until this time; the two parted company as the concept of mastery of nature achieved its definitive modern form. Number, which first issued from dissociation from the natural world, ended up describing and dominating it.

Fontenelle's *Preface on the Utility of Mathematics and Physics* (1702) celebrated the centrality of quantification to the entire range of human sensibilities, thereby aiding the eighteenth century consolidation of the breakthroughs of the preceding era. And whereas Descartes had asserted that animals could not feel pain because they are soulless, and that man is not exactly a machine because he had a soul, LeMetrie, in 1747, went the whole way and made man completely mechanical in his *L'Homme Machine*.

Bach's immense accomplishments in the first half of the eighteenth century also throw light on the spirit of math unleashed a century earlier and helped shape culture to that spirit. In reference to the rather abstract music of Bach, it has been said that he "spoke in mathematics to God." (LeShan & Morgenau 1982) At this time the individual voice lost its independence and tone was no longer understood as sung but as a mechanical conception. Bach, treating music as a sort of math, moved it out of the stage of vocal polyphony to that of instrumental harmony, based always upon a single, autonomous voice fixed by instruments, instead of somewhat variable with human voices.

Later in the century Kant stated that in any particular theory there is only as much real science as there is mathematics, and devoted a considerable part of his *Critique of Pure Reason* to an analysis of the ultimate principles of geometry and arithmetic.

Descartes and Leibniz strove to establish a mathematical science method as the paradigmatic way of knowing, and saw the possibility of a singular universal language, on the model of empirical symbols, that could contain the whole of philosophy. The eighteenth century Enlightenment thinkers actually worked at realizing this latter project. Condillac, Rousseau and others were also characteristically concerned with origins—such as the origin of language; their goal of grasping human understanding by taking language to its ultimate, mathematized symbolic level made them incapable of seeing that the origin of all symbolizing is alienation.

Symmetrical plowing is almost as old as agriculture itself, a means of imposing order on an otherwise irregular world. But as the landscape of cultivation became distinguished by linear forms of an increasingly mathematical regularity—including the popularity of formal gardens—another eighteenth-century mark of math's ascendancy can be gauged.

In the early 1800s, however, the Romantic poets and artists, among others, protested the new vision of nature as a machine. Blake, Goethe and John Constable, for example, accused science of turning the world into a clockwork, with the Industrial Revolution providing ample evidence of its power to violate organic life.

The debasing of work among textile workers, which caused the furious uprisings of the English Luddites during the second decade of the nineteenth century, was epitomized by such automated and cheapened products as those of the Jacquard loom. This French device not only represented the mechanization of life and work unleashed by seventeenth century shifts, but directly inspired the first attempts at the modern computer. The designs of Charles Babbage, unlike the "logic machines" of Leibniz and Descartes, involved both memory and calculating units under the control of programs via punched cards. The aims of the mathematical Babbage and the inventor-industrialist J.M. Jacquard can be said to rest on the same rationalist reduction of human activity to the machine as was then beginning to boom with industrialism. Quite in character, then, were the emphasis in Babbage's mathematical work on the need for improved notation to further the processes of symbolization, his *Principles of Economy*, which contributed to the foundations of modern management—and his contemporary fame against London "nusiances," such as street musicians!

Paralleling the full onslaught of industrial capitalism and the hugely accelerated division of labor that it brought was a marked advance in mathematical development. According to Whitehead, "During the nineteenth century pure mathematics made almost as much progress as during the preceding centuries from Pythagoras onwards."

The non-Euclidean geometries fo Bolyai, Lobachevski, Riemann and Klein must be mentioned, as well as the modern algebra of Boole, generally regarded as the basis of symbolic logic. Boolean algebra made possible a new level of formulized thought, as its founder pondered "the human mind . . . and instrument of conquest and dominion over the powers of surrounding nature," (Boole 1952) in an unthinking mirroring of the mastery mathematized capitalism was gaining in the mid-1800s. (Although the specialist is rarely faulted by the dominant culture for his "pure" creativity, Adorno adroitly observed that "The mathematician's resolute unconsciousness testifies to the connection between division of labor and 'purity'.")

If math is impoverished language, it can also be seen as the mature form of that sterile coercion known as formal logic. Bertrand Russell, in fact, determined that mathematics and logic had become one. Discarding unreliable, everyday language, Russell, Frege and others believed that in the further degradation and reduction of language lay the real hope for "progress in philosophy."

The goal of establishing logic on mathematical grounds was related to an even more ambitious effort by the end of the nineteenth century, that of establishing the foundations of math itself. As capitalism proceeded to redefine reality in its own image and became desirous of securing its foundations, the "logic" stage of math in the late 19th and early 20th centuries, fresh from new triumphs, sought the same. David Hilberts theory of formalism, one such attempt to banish contradiction or error, explicitly aimed at safeguarding "the state power of mathematics for all time from all 'rebellions'."

Meanwhile, number seemed to be doing quite well without the philosophical underpinnings. Lord Kelvin's late nineteenth century pronouncement that we don't really know anything unless we can measure it bespoke an exalted confidence, just as Frederick Taylor's Scientific Management was about to lead the quantification edge of industrial management further in the direction of subjugating the individual to the lifeless Newtonian categories of time and space.

Speaking of the latter, Capra has claimed that the theories of relativity and quantum physics, developed between 1905 and the late 1920s, "shattered all the principal concepts fo the Cartesian world view and Newtonian mechanics." But relativity theory is certainly mathematical formulism, and Einstein sought a unified field theory by geometrizing physics, such that success would have enabled him to have said, like Descartes, that his entire physics was nothing other than geometry. That measuring time and space (or "space-time") is a relative matter hardly removes measurement as its core element. At the heart of quantum theory, certainly, is Heisenberg's Uncertainty Principle, which does not throw out quantification but rather expresses the limitations of classical physics in sophisticated mathematical ways. As Gillespie succinctly had it, Cartesian-Newtonian physical theory "was an application of Euclidean geometry to space, general relativity a spatialization of Riemann's curvilinear geometry, and quantum mechanics a naturalization of statistical probability." More succinctly still: "Nature, before and after the quantum theory, is that which is to be comprehended mathematically."

During the first three decades of the 20th century, moreover, the great attempts by Russell & Whitehead, Hilbert, et al., to provide a completely unproblematic basis for the whole edifice of math, referred to above, went forward with considerable optimism. But in 1931 Kurt Godel dashed these bright hopes with his Incompleteness Theorem, which demonstrated that any symbolic system can be either complete or fully consistent, but not both. Godel's devastating mathematical proof of this not only showed the limits of axiomatic number systems, by rules out enclosing nature by any closed, consistent language. If there are theorems or assertions within a system of thought which can neither be proved or disproved internally, if it is impossible to give a proof of consistency within the language used, as Godel and immediate successors like Tarski and Church convincingly argued, "any system of knowledge about the world is, and must remain, fundamentally incomplete, eternally subject to revision." (Rucker 1982)

Morris Kline's *Mathematics: The Loss of Certainty* related the "calamities" that have befallen the once seemingly inviolable "majesty of mathematics," chiefly dating from Godel. Math, like language, used to describe the world and itself, fails in its totalizing quest, in the same way that capitalism cannot provide itself with unassailable grounding. Further, with Godel's Theorem mathematics was not only "recognized to be much more abstract and formal than had been traditionally supposed," but it also became clear that "the resources of the human mind have not been, and cannot be, fully formalized." (Nagel & Newman 1958)

But who could deny that, in practice, quantity has been mastering us, with or without definitively shoring up its theoretical basis? Human helplessness seems to be directly proportional to mathematical technology's domination over nature, or as Adorno phrased it, "the subjection of outer nature is successful only in the measure of the repression of inner nature." And certainly understanding is diminished by number's hallmark, division of labor. Raymond Firth accidentally exemplified the stupidity of advanced specialization, in a passing comment on a crucial topic: "the proposition that symbols are instruments of knowledge raises epistemological issues which anthropologists are not trained to handle." The connection with a more common degradation is made by Singh, in the context of an ever more refined division of labor and a more and more technicised social life, noting that "automation of computation immediately paved the way for automatizing industrial operations."

The heightened tedium of computerized office work is today's very visible manifestation of mathematized, mechanized labor, with its neo-Taylorist quantification via electronic display screens, announcing the "information explosion" or "information society." Information work is now the chief economic activity and information the distinctive commodity, in large part echoing the main concept of Shannon's information theory of the late 1940s, in which "the production and the transmission of information could be defined quantitatively." (Feinstein 1958)

From knowledge, to information, to data, the mathematizing trajectory moves away from meaning—paralleled exactly in the realm of "ideas" (those bereft of goals or content, that is) by the ascendancy of structuralism. The "global communications revolution" is another telling phenomenon, by which a meaningless "input" is to be instantly available everywhere among people who live, as never before, in isolation.

Into this spiritual vacuum the computer boldly steps. In 1950 Turing said, in answer to the question 'can machines think?', "I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted." Note that his reply had nothing to do with the state of machines but wholly that of humans. As pressures build for life to become more quantified and machine-like, so does the drive to make machines more life-like.

By the mid-'60s, in fact, a few prominent voices already announced that the distinction between human and machine was about to be superseded—and saw this as positive. Mazlish provided an especially unequivocal commentary: "Man is on the threshold of breaking past the discontinuity between himself and machines . . . We cannot think any longer of man without a machine . . . Moreover, this change . . . is essential to our harmonious acceptance of an industrialized world."

By the late 1980s thinking sufficiently impersonates the machine that Artificial Intelligence experts, like Minsky, can matter-of-factly speak of the symbol-manipulating brain as a "computer made of meat." Cognitive psychology, echoing Hobbes, has become almost based on the computational model of thought in the decades since Turing's 1950 prediction.

Heidegger felt that there is an inherent tendency for Western thinking to merge into the mathematical sciences, and saw science as "incapable of awakening, and in fact emasculating, the spirit of genuine inquiry." We find ourselves, in an age when the fruits of science threaten to end human life altogether, when a dying capitalism seems capable of taking everything with it, more apt to want to discover the ultimate origins of the nightmare.

When the world and its thought (Levi-Strauss and Chomsky come immediately to mind) reach a condition that is increasingly mathematized and empty (where computers are widely touted as capable of feelings and even of life itself), the beginnings of this bleak journey, including the origins of the number concept, demand comprehension. It may be that this inquiry is essential to save us and our humanness.

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John Zerzan
Number: Its Origin and Evolution

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