Creativity and Curriculum in the Emerging Age of Nonlinear Physics

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We publish here Part 1 of a two-part policy paper released by the LaRouche Democratic Campaign on February 5. The document was introduced by the following memorandum:

> **To: Those concerned with secondary education**
> **Subject: Creativity and secondary curriculum**
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> From the establishment of the Brothers of the Common Life, through the Humboldt reforms of the nineteenth century, the development of an improved approach to secondary education has provided Western civilization numerous among its best adult minds. In this and other ways, such programs have made possible successful democratization of the processes of representative government, and have greatly facilitated many other benefits of which our Western civilization should be proud.
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> During the course of the present century, especially since approximately 1963, the quality of both public and university education has been systematically eroded through such influences as those of John Dewey and his more radical successors. The most recent erosion in this direction has greatly undermined all aspects of both popular life and representative self-government.
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> Now, technology progress presents us with the challenge of an age of nonlinear physics and biophysics. Without a return to classical standards of secondary education, our labor-force will be underqualified to meet the challenge. Without subtracting anything from earlier arguments for classical education, I add the current challenge as my point of emphasis.
>
> Sincerely Yours,
> Lyndon H. LaRouche, Jr.

The worst of the evil done to Western civilization by the professed malthusians Charles Darwin and Thomas Huxley, was that they degraded mankind implicitly to the moral condition of the beasts. Out of this has come the academic popularity of such absurdities as the attempt to derive a human psychology from the study of behavior of animals.

Kindred views have affected the shaping of policies of education, to the effect of a downgrading of the primary mission of secondary education: the development of the distinctively human potentialities of the adolescent to the highest possible level of general capability for successful adaptability to both the foreseen and unforeseen challenges of adult life.

My purpose here, is to make clear why, unless we return to the principles of classical secondary education, the next two generations of pupils will generally lack the ability to cope successfully with the new forms of technological and other challenges presented—in higher education and adult life generally—during the remainder of this century and the early decades of the next.

To show that connection clearly, two general points must be explained. We must define rigorously what the term “creativity” signifies, and show the rather unique way in which classical education fosters the student’s potential for creative thinking. We must examine also the new way in which emerging technological and other developments challenge the student’s and adult population’s potentials for such creative thinking. First, I state my specialized qualifications for treating these subject-matters.

By profession, I am a specialist in physical economy, a branch of physical science founded by Gottfried Leibniz. In the simplest aspect, this treats the relationship between the amount of usable energy supplied to society, per capita and per square kilometer of land-area used, and the potential rate of increase of the productive powers of that society. In the second degree, it examines the relationship between the way in which the internal organization of powered machinery, and analogous means, increase the potential productivity per unit of usable energy consumed. The second aspect of the study of physical economy, is the meaning which Leibniz supplied to the German and English terms “technology,” and to the French and Italian translations of this, “polytechnique.”

My collaborators and I have contributed to the progress of work in this profession, as any professional should. My original contribution to the field has been made in connection with the generation of more advanced forms of technology by the creative processes of the human mind. My narrow objective has been to show how an intelligible representation could be provided for those mental-creative processes by means of which the individual effects, and assimilates a valid fundamental discovery in physical science.

By aid of such representations, it has become possible to show a cause-effect relationship between mental-creative activity and increase of the potential productive powers of labor.

By aid of these studies, one can demonstrate from the internal evidence of the work of Leonardo da Vinci, for example, or the compositions of Bach, Mozart, and Beethoven, that the quality of greatness in artistic composition flows from the same creative processes of mind generating valid fundamental discoveries in physical science.

The quality of natural beauty, with which all classical fine art begins, is harmonic orderings congruent with the principle of the Golden Section of isoperimetric (e.g., circular) action. The mathematical physics of Carl Gauss *et al.* shows the claims of such as Plato, Luca Pacioli, Leonardo da Vinci, and Johannes Kepler to have been correct on this point. From the modern vantage-point in physics and biophysics, we are able to show that what these forebears identified to be the principle of natural beauty, coheres with the most fundamental aspect of universal physical laws: what is termed the "curvature" of physical space-time, as such "curvature" is defined in the terms of reference of the Gauss-Riemann complex domain.

The important point to be added, respecting classical fine art, is that, although no work of art is sound if it violates the harmonic principles of natural beauty, the mere imitation of the beauty of nature, however perfect the copy, is not art.

Classical art never violates natural beauty; but that which distinguishes it as art, is that the creative powers of the artist's mind supply a crucial added element to the domain of natural beauty. This added element orders the artistic work as a human composition. That which thus orders the process of artistic composition, is a product of the same mental processes, engaged in the same form of activity responsible for the generation and assimilation of valid fundamental advances in scientific knowledge.

From the standpoint of the creative powers of mind, science and art form a unity. The view of classical Athenian art and Socratic method, as exemplified by St. Augustine on this subject, is the root of Western European classical culture. That Augustinian view, as reaffirmed by the greatest minds of the Golden Renaissance, is the foundation of classical humanism.

By "classical humanism," we signify a viewpoint which is opposed in every respect to the so-called "secular humanism" of both Romanticism and modernist philosophical radicalism.

Classical education, as this term should be understood to apply most emphatically to secondary curricula, signifies those facets of education which bear directly upon the employment and development of such creative potentials. We use the term "classical education" here, to signify not only the study of valid fundamental discoveries in physical science and the classical fine arts, but also history studied from this same vantage-point.

My undertaking in this report, is to render intelligible the most crucial features of a classical form of secondary education, and also to indicate the reasons why a return to the standpoint of classical humanist education is indispensable to qualify adolescent youth for meeting the challenges of the emerging age of nonlinear physics and biophysics, both in higher education and in life generally.

1. Classical Humanism

What is called the Golden Renaissance, or, more commonly, simply "The Renaissance," presented the case for classical humanism on Christian religious grounds. The best example of this is the leading role of Cardinal Nicholas of Cusa, one of the architects of the 1439 Council of Florence, and, during the later period of his life, chief canon of the Papacy. Cusa was also the founder of modern physical science, beginning with such books as his 1440 *De Docta Ignorantia* (*On Learned Ignorance*). In physical science, Cusa's followers include Luca Pacioli, Leonardo da Vinci, Raphael and his school, Johannes Kepler, and, in matters of scientific method and principles, Gottfried Leibniz.

Under our law, all arguments for public policy must be presented from an ecumenical standpoint, which does not depend upon any the peculiar doctrines of any religious denomination. Since we are all Augustinians by heritage, including Ashkenazi Judaism's followers of Philo Judeaus, the secular standpoint within all nations of Western European civilization, including our own, is consistent with that ecumenical Judeo-Christian framework of religious and moral belief. Happily, as the case of Nicholas of Cusa illustrates the facts of the matter, we can state the case for classical humanism effectively from the standpoint of reference of physical science, as I do here.

The simplest, most direct proof of the principles of classical humanism, is made along the following lines.

According to modern anthropologists, the early condition of human society is what they term a "primitive hunting and gathering society," an echo of the cultural life of troops of chimpanzees or baboons. Anthropologists have shown us numerous cases, in which cultures have degenerated from a relatively higher state into forms of life with some resemblances to such a "hunting and gathering society." We avoid the speculative arguments of the anthropologists on these matters; we accept the observation that a hunting and gathering society is the lowest form into which human existence might fall. To that degree, with no other assumptions attached, the example is a useful one for our purposes here.

My colleagues and I have used our professional skills in physical economy to conduct studies of the economy of such a hunting and gathering society. The calculations are as follows.

If we presume wilderness conditions to prevail throughout our planet many thousands of years ago, we know that approximately 10 square kilometers of average land-area would be required to prove the bare biological subsistence of the average human individual. We know that, under these conditions, the life-expectancies of those individuals would be significantly less than 20 years of age. The level of culture would be that of a clever sort of baboon, a human culture which compensates in cleverness for the superior relative strength of the baboon. The maximum level of the human population on this planet, under such conditions, would be approximately 10 million living individuals.

Presently, there are more than 5 billion individuals existing on this planet. Did we use even existing levels of modern technology fully, we could sustain a population of approximately 15 billion persons at a higher standard of living than that prevailing in Western Europe and North America during the earliest 1970s. Three lines of current advance, high-energy plasma physics, coherent electromagnetic pulses, and optical biophysics, represent potentially the highest rate of increase of humanity's productive population-potential in the history of our species. By aid of these technologies, we might assuredly begin mankind's colonization of other planets within about 50 years.

We have good estimates of the population-density of our species during the past thousands of years. For example: From studies of the urban civilization of the Dravidians of the Indus riparian region, we can estimate the extent and population of that "Harappan" culture during the third millennium B.C. We have good estimates for the population-density of the Mediterranean littoral and Western Europe during Roman times. Since that point, we have a generally improving accuracy of population-densities as we move along the centuries up to the present time. Our better quality of knowledge to this effect begins with the census of Charlemagne; through studies of urban centers and Catholic parishes, we have good knowledge of the collapse of the population of Western Europe over the period of approximately 100 years, from the middle of the thirteenth through the middle of the fifteenth centuries. The best quality of our knowledge of modern historical demography, begins during the period of generally rapid upward growth of population worldwide, launched by the Golden Renaissance, following the catastrophes of the fourteenth century.

If we take into account the lowering of productivity per capita through effects of human slavery and other widespread usurious practices, we are able to show a causal relationship between levels of technology practiced and rates of growth of population-densities over these thousands of years.

So, we are able to demonstrate that the increase of the potential population-density of the human species is the result of what we call today "scientific and technological progress." By these means, mankind has so far increased humanity's potential population-density more than a thousandfold, above the level of "primitive hunting and gathering society"—three orders of magnitude.

By the same means, we have increased the potential standard of living of persons. We have increased life-expectancies for populations with good nourishment and sanitation to ceilings of about 85 years, before the cumulative effects of diseases of aging of tissue take their ultimate toll. In optical biophysics, we are presently at the threshold of mastering such diseases of aging of tissue as cardiovascular diseases, cancer, and neurological senility. There is no reason to doubt that the ceiling on aging could touch 120 years or so during the first half of the coming century, wherever nutrition, sanitation, and applications of optical biophysics are provided to accomplish this.

This improvement above the condition of "primitive society" is implicitly measurable. To construct such measurements, we begin with a "market-basket" of physical goods per capita. Even services, such as science, can be measured by aid of these means. As technological progress effects economy of labor in producing for physical needs, we are able to decrease the percentage of the total 1abor-force required to satisfy even increasing physical quantities of those needs, to leave more years of life available for education, and to devote increasing portions of our labor-force's employment to providing scientific and related services.

Generally, these advances can be expressed in units of usable forms of energy-throughput per capita and per square kilometer of land-area. The raw amount of usable energy, per capita and per square kilometer, must increase; the density of energy applied to a square centimeter of work-area in production must increase. Crude estimates, in terms of kilowatts per per-capita unit of population-density, enable us to describe improvement of the conditions of life of the individual in orders of magnitude.

The application of scientific and technological progress, in the sense we have described that here, has improved the human material condition of life potentially more than 1-millionfold over the condition of primitive society. If we use fully the new technologies now coming into view, that improvement could become 100-millionfold, or even more, during the course of the coming century.

No species of beast could improve its characteristic potential population-density, by its own means, by even a tiny fraction of a single order of magnitude, except by becoming a new species.

So, from the vantage-point of physical economy, the elementary distinction between man and beast is mankind's ability to generate and assimilate efficiently what we term "scientific and technological progress."

If we examine the progress of physical science in the terms of reference provided us by such as Cusa, Leonardo, Kepler, Leibniz, and Gauss, we are able to show that the progress of scientific knowledge is delimited by certain permanent principles rightly termed "laws of the universe." What scientific progress accomplishes, is an increase of the efficiency with which human exertion is applied purposefully to our universe. The less imperfectly we understand those laws, the less imperfect our efforts, and the greater our potential population-density becomes.

For most educated persons today, there is a formal difficulty in what I have just reported. Those who imagine the laws of the universe to be fixed in the way a Descartes, or Newton, or Maxwell insist, must either underrate mankind's powers to alter conditions in the universe qualitatively, or would assume what we can show possible for science now to represent an overturning of universal physical laws.

This apparent difficulty vanishes, if we define the laws of the universe as Cusa and Kepler did. Instead of assuming, wrongly, that the laws of physics are mechanical ones, we must accept the fact that what appear to be mechanical sorts of laws of physics are changeable by man's actions. That does not mean that man has the power to change the actual laws of the universe; it merely shows that Descartes, Newton, and so forth have defined the meaning of "physical laws" wrongly. The true laws of our universe govern the way in which we are permitted to change what Descartes, Newton, *et al.* insist are the mechanical "laws of physics."

I shall turn our attention to the practical implications of that issue, as far as this bears upon the importance of laying the basis for mastery of the Gauss-Riemann complex domain in secondary education, in the proper location here. Having merely identified the existence of such a consideration, I now resume our approach to the crucial point.

All scientific progress depends upon a capability of the human mind which is lacking in the beasts, the creative potential of the human mind. The controversial point I now introduce, is this: that the mission of secondary education is not to prepare a pupil for a specific sort of higher education or employment, but rather the broad development of the creative potential of the adolescent mind. This is the proper meaning of "classical humanism" in secondary education, as that has been understood by the leading proponents of such classical secondary education since the Brothers of the Common Life.

2. Classical Education

Classical education signifies two things. Over the long reach of its existence in Western European civilization, it pertains to a method of education, with included emphasis upon the classical fine arts, history, and pre-scientific curricula. In any period of progress of our culture, it means situating the general principles of classical secondary education in terms of reference to the existing state of mankind, including the presently emerging levels of scientific progress.

It means making the secondary student conscious of the role of the creative process in history, and use of selected primary source-materials of literature and experimental demonstrations, to cause the pupil to become familiar with the habits of thought exhibiting the creative workings of individual minds. To assimilate that experience from the past, such as crucial scientific experiments, in such a manner, the pupil is obliged to bring to bear his or her own creative potentials, to attempt to reproduce in his or her mind the same kind of mental processes employed by the great discoverers of the past.

This requires a shift away from the commonplace practice in writing and classroom use of textbooks today. The emphasis is placed upon selections of primary source materials from the periods in which great accomplishments were contributed. The modem textbook “explains away” precisely that reexperience of past discoveries which is most essential to fostering the student’s mental-creative potentials.

Take, as a case in point, the teaching of the differential calculus.

The idea of a differential calculus was discovered by Johannes Kepler. Kepler specified the requirements for this in his published writings. On the basis of Kepler’s specifications, the construction of a differential calculus was undertaken by Blaise Pascal. Leibniz had begun work along the same lines, based on Kepler’s specifications, before settling in Paris for advanced studies, during the years 1672–76. During those four years, Leibniz worked through the private papers of Pascal, and completed the elaboration of a differential calculus in a paper submitted to his publisher, before leaving Paris, in 1676.

The London Royal Society devoted the succeeding ten years to an effort to rebut Leibniz’s work on the calculus, with the result that Newton’s doctrine of fluxions appeared a decade after Leibniz’s original dissertation on the differential calculus. What Newton produced was not a differential calculus, but rather the attempt to simulate the results of Leibniz’s calculus by use of previously well-established mathematics of “infinite series.” By the beginning of the nineteenth century, Newton’s pseudo-calculus had been scrapped, although the work on “infinite series” as such was retained.

During the 1820s, a powerful factional opposition to the London Royal Society emerged around Edinburgh and Cambridge universities in Britain. The famous Charles Babbage was a prominent public figure of this faction, and so a contributor to the later establishment of the British Association for the Advancement of Science, the mother-organization for the American Association for the Advancement of Science (AAAS). This faction pointed out that no one in Britain (during the 1820s) could match the level of science then practiced on the continent of Europe or in the United States. Babbage and his anti-malthusian backers proposed to remedy this lamented state of affairs.

Among the factional papers produced by this faction in Britain was a dissertation, "D-ism and Dot-age," in which "D-ism" signifies Leibniz's differential calculus, and "Dotage" Newton's dogma of "fluxions." As a result, the symbolism and algebraic features of Leibniz's calculus were standardized in the English-language textbooks of the nineteenth and twentieth centuries.

What these textbooks produce is not the differential calculus itself, but rather some of the derived algebraic features of that calculus, explained from the standpoint of Leibniz's bitter adversaries, the French Cartesians. Augustin Cauchy was at the center of this neo-Cartesian parody of the differential calculus. The differential calculus is taught from Cauchy's standpoint in the textbooks and relevant classrooms today.

The result of this arrangement of textbook-education, is that the presentation of the principles of a differential calculus is mystified in the most damaging way. The proper approach avoids these commonplace problems.

The use of crucial primary historical sources makes the principles of the calculus readily available in a demystified and comprehensible way to graduates of secondary schools. This is accomplished by including the treatment of the calculus within the proper ordering of the student's tracing of the steps of progress, since the fifteenth-century Renaissance, leading up into the work of Kepler, and the work of Desargues, Fermat, Pascal, and Leibniz.

The method required to effect this result, is the teaching of elementary constructive geometry by teachers who know this material from an advanced standpoint. This example is used here to illustrate some general features of classical humanist modes of secondary education.

For the mastery of mathematical physics up to the work of Carl Gauss, two elementary notions of mathematical physics must become intelligible to the student, in terms of proofs. On the side of mathematics as such, the student must master what is known, since the work of Bernoulli and Euler, as the "isoperimetric theorem" of topology. On the side of physics, the isoperimetric principle of topology is known as Leibniz's Principle of Least Action. Both conceptions are introduced to modern physical science by Nicholas of Cusa, in his 1440 *De Docta Ignorantia*.

At the outset, until the student has progressed to about the level of the tenth through thirteenth books of Euclid's *Elements*, and also Archimedes' theorems on the subject of the quadrature of the circle, the student is not equipped to reconstruct proofs of sufficient rigor to make truly intelligible the notions of isoperimetry and least action. However, from the beginning of instruction of students in constructive geometry, as Jakob Steiner's text Synthetic Geometry illustrates this, the teachers must recognize the concepts of isoperimetry and least action as educational goals toward which the process of education in constructive geometry is leading.

The introduction of Luca Pacioli's reconstruction of proof for the uniqueness of the constructability of the five Platonic solids comes in naturally during the portion of the constructive-geometry curriculum referencing the contents of the tenth through thirteenth books of Euclid's *Elements*. Also to be introduced at this point, is the work of Pacioli, Leonardo da Vinci and their collaborators on the proof that all healthy living processes are distinguished by morphological patterns of growth and derived function harmonically congruent with the Golden Section.

The teacher, at this point, teaches such historical materials of the internal history of scientific progress from the vantage-point of the later work of Kepler and of Euler, Bernoulli, and Gauss. The rule, again, is elementary principles taught simply, but under guidance of an advanced standpoint.

On the basis of these foundations, the students are prepared to be introduced to the most crucial features of the work of Kepler. Properly prepared classes are able to handle such material at the levels of the tenth and eleventh grades. Kepler's famous paper on the snowflake should be emphasized: The relationship between isoperimetry and physical least action begins thus to be understood in practical terms of reference.

Kepler's astrophysics, including his treatment of the relationship between magnetism and universal gravitation, should be taught from the vantage-point of the teacher's knowledge of the work of Gauss on these matters. Accordingly, the teacher introduces the notion of self-similar-spiral action at this point, and shows how plane projections of elliptic cross-sections of conic self-similar spirals bear upon the elliptic characteristics of the Kepler orbits and the harmonic characteristics of those orbits.

The gifted student at that level will recognize more or less readily the significance of the notion "curvature of physical space-time." Although other sectors of the class may not see this so clearly, the teacher must understand this, and guide the instruction in the way which leads the students toward later comprehension of this matter.

The significance of Kepler's specifications for development of a differential calculus and elliptic functions are introduced at that point. The first objective is to lead the student through the work of Pascal and Leibniz, to the effect that the student reconstructs an elementary differential calculus as were it his or her own discovery from the standpoint of geometrically-determined difference functions. The second, related objective, is to develop Leibniz's notion of least action from this same standpoint, aided by primary source materials from Fermat, and crucial-experimental forms of demonstration of least action in terms of refraction of light. The same approach, incorporating the indicated emphasis on self-similar-spiral action as a higher (than simply circular) form of physical least action, lays the basis for the twelfth-grade student's grasp of the rudiments of elliptic functions and of the complex domain generally.

That is an abbreviated overview, but it illustrates the point. Instead of the student's regurgitating an approved form of textbook response to a question, or employing a textbook procedure for solving a problem, the student must respond from the standpoint of his or her own independent knowledge. By "independent knowledge," one ought to signify the ability to reconstruct the proof for everything which the student adopts as knowledge.

The most important aspects of such "independent knowledge," are those pertaining to what are called "crucial experiments," experiments which demonstrate a principle of science, and do this in a way which overturns what previous opinion has adopted as perfected principles.

The same principle applies to the classical fine arts. The student must be led to the ability to adduce, as independent knowledge, the purpose achieved by each aspect of classical fine art. This must be accomplished by demonstration of the principles shown in selected primary historical sources. The student must be able to construct examples which demonstrate those principles efficiently.

All of this, classical approach to development of scientific method and of classical fine arts, must be situated in a view of current events as "present history." History, past, and future, is taught from this vantage-point, to the effect that the student views the present as acting upon the results of past history to produce future history.

History is best taught on the secondary level from the standpoint of reference to classical tragedy. The models of Aeschylos, Shakespeare, and Schiller are the most essential, but Cervantes' *Don Quixote* should also be referenced as a form of classical tragedy. By aid of this approach, the student is situated to distinguish between problems and man-made crises in history. For every problem, there is a potential solution; "crises" signify the calamities which result when leading institutions, or individuals, stubbornly fail to develop and apply available practical remedies for major problems of society in general, or individual life in particular.

The approach to the subject of history from the vantage-point of the principles of classical tragedy, impels the student to view the knowledge gained from science and classical fine arts as indispensable weapons for the shaping of history. The principles learned from scientific and classical education are identified as guides to practical action in both statecraft and daily life. The student grasps the point, "What I do with my life can make a difference in determining the opportunities in future history." The student grasps the point, that the creative potentials of his or her mind make a difference in shaping the outcome of present history, and that he or she is an important person for society as a whole on that account.

The student develops a sense of certainty respecting the fact that what makes each of us human, above the beasts, is the creative potential of the individual human mind, and nothing but that.

In modern times, the term "humanism" has been used often to imply an anti-religious standpoint. "Secular humanism," means that and more. Classical humanism signifies that the human individual's creative potentials are the individual personality, the soul, and that it is this aspect of the individual which is in the image of the living God. This signifies, that only from the standpoint of development of those creative potentials, is mankind capable of knowledge of the lawful ordering of universal creation, and is mankind capable of being better morally than a beast to mankind.

The function assigned to classical secondary education, is to bring to the highest relative degree of general development, those creative potentials of the individual which set mankind above the beasts. Youth so developed represent the optimal capability for effective response to whatever challenges higher education, employment, and adult life generally may present to them.

3. The 'Hereditary Principle'

As I have stated here earlier, my most important contribution to the science of physical economy is a fresh proof that the creative processes of the individual human mind are susceptible of intelligible representation by the conscious human mind. By "intelligible representation," I mean, inclusively, the sort of rational representation we associate with the idea of mathematical physics.

The qualification I must add to that, is that creative mental processes can not be represented by any linear "models." No system of formal deductive reasoning could describe such processes. In the language of mathematics, the creative processes are intrinsically "nonlinear." The problem of intelligible representation of creative processes was the particular concern of one among the greatest scientific geniuses of the nineteenth century, Prof. Bernhard Riemann, the acknowledged pioneer in physical relativity. Once I had defined the conditions for intelligible representation of creative processes, by the early 1950s, I turned to the work of Riemann and one of his important successors, Georg Cantor, to identify the specific mathematical methods needed for an adequate representation of my solution to the problem.

My work on this subject was prompted by a commitment to refute the absurdity of Prof. Norbert Wiener's dogma of statistical "information theory." My initial proofs of Wiener's absurdity took the form of an attack upon the central fallacy in the work of Immanuel Kant, specifically Kant's arguments of the impossibility of conscious representation of what he termed "synthetic judgment *a priori*." My approach was to stretch the capabilities of formal deductive logic to their limits, where deductive logic breaks down. This section is a summation of that first step of my proof.

The most convenient model of a formal deductive logic is Euclid's *Elements*. The appropriateness of this choice is severalfold.

Euclid's *Elements* is sometimes identified as the work of a "false Euclid." The work appears to have been composed, at least in the main part, in Ptolemaic Egypt during approximately the second century B.C. The internal evidence from the work itself indicates that these books were an eclectic potpourri of work done a century or more earlier, in Magna Graecia, Athens, and the Cyrenaic temple of Ammon, plus some additional elements on conics taken from the school of geometry at Alexandria. The original work appropriated so had been a study of geometry based upon what we term today "constructive" or "synthetic methods." Euclid's *Elements* is chiefly a rewriting of the work from those various earlier sources, an attempt to restate these theorems according to the terms of a formal deductive nominalism.

Ptolemaic rewriting of geometry along deductive lines coincided with the introduction of the nominalist form of grammar imposed upon the Latin. Earlier, as Panini's philology from approximately the fifth century B.C. insisted, the Indo-European languages were based on transitive verbal action, rather than nouns. This also coincided with the production of the hoax called the Ptolemaic system of astronomy, proven to have been a reworking, from a deductive standpoint, of a more accurate solar astronomy established by classical Greek culture about a century earlier. Indeed, the earliest known calendars were solar-astronomical calendars (not, as is commonly argued, Mesopotamian lunar calendars). This was the same period in which the variety of sophistry known as Stoicism was introduced, to become later, with Epicureanism, the characteristic outlook of degenerating Roman imperial culture.

In the appropriate later location here, I shall indicate the significance of those coincidences of the second century B.C. for the practical problems in philosophy of education today.

A deductive geometry has two cohering primary limitations. First, it prohibits a consistent form of intelligible representation of entire classes of forms which exist in the physical universe. It suffers also a directly related fallacy, that all forms of mathematics premised upon the model of a deductive logic are capable of only linear representation of processes, whereas all of the most important classes of physical processes are intrinsically "nonlinear."

All mathematics based upon formal deduction begins with the adoption of two classes of purely arbitrary assumptions. The first class of such arbitrary assumptions we term "axioms." The second class, we term "postulates."

Axioms are asserted, without proof, merely upon the premise that their universal truthfulness ought to be considered "self-evident." So, we have the false and absurd assumption of the self-evident existence of a point, and that a straight line is defined as the shortest distance between two points. From axioms of such a character, an entire deductive system of mathematics is constructed.

The postulates are added in the effort to avoid certain among the insoluble ambiguities and falsehoods intrinsic in any axiomatic system. The addition of the famous "parallel postulate" in formal Euclidean geometry is an example of this. In other words, the axioms are fundamental, and the postulates added patch-work assumptions, also submitted without proof, and treated as if they were axioms.

If we begin to reconstruct any deductive geometry from the starting-point of a set of adopted axioms and postulates, we obtain results which are summed up under the title of an "hereditary principle" of any formal deductive system. It is the examination of that "hereditary principle" which leads us to the first stage of successive proofs of the intelligibility of individual creative-mental processes.

Starting with the set of axioms and postulates, we derive a combinatorial set of deductive theorems directly from those axioms and postulates. By combinations of the same axioms and postulates with that first layer of theorems, the latter now treated as postulates, we derive a second layer of theorems. This process can be repeated more or less indefinitely.

The result of a continuing iterative process of this sort defines an open-ended lattice, in which each point of the lattice corresponds either to an axiom, postulate, or theorem of the lattice as a whole.

For that reason, any theorem which is proven not to be inconsistent with any among the axioms, postulates, and theorems which precede it, in that ordering of iteration, contains nothing which is not implicit in the original set of axioms and postulates. This is the significance of the term "hereditary principle" used in that context.

There are paradoxes to which such deductive systems lead us whenever physical science produces a crucial experimental discovery, the latter the simplest model of a product of creative-mental activity by an individual mind.

I use the more popular scientific term, "crucial experiment," in the restricted sense of a Riemannian "unique" experiment. As a model of such a unique experiment, one may choose Riemann's own famous 1859 paper, "On the Propagation of Plane Air Waves of Finite Amplitude." Not only did that paper define the principles of transonic and supersonic flight of powered aircraft, but, as Lord Rayleigh, among others stressed, if powered transonic flight were possible, then the gas theory which Rayleigh defended was experimentally absurd. By "unique experiment," one signifies an experiment so designed that it demonstrates a principle of nature, and thus overthrows all theory which presumes a contrary result.

In the case such a "crucial" experiment demonstrates a theorem contrary to an existing body of scientific opinion, what is proven is not only that a contrary theorem is wrong; it is also proven that the entire body of mathematical physics containing the argument disproven is wrong. Hence, the popularity of the term "crucial" for such experiments; for special reasons, which will become plainer, I prefer Riemann's designation of "unique."

There are certain preconditions attached to defining an experiment as "unique." Those matters of experimental method are not at issue, so we need not treat them here; it is sufficient to know that our discussion here is limited to that class of experiments which satisfies those preconditions. For the moment, we limit the discussion to the scope of mathematical physics.

In the case a unique experiment disproves an important theorem of some deductively consistent body of mathematical physics, the first measure to be taken is to apply the "hereditary principle" of deductive lattices to that body of mathematical physics as a whole. At the very least, one or more of the set of axioms and postulates of that system must be destroyed, and this action must be continued until we have rooted out every axiom and postulate which is inconsistent with the results of the unique experiment.

As a result, we have then two deductive mathematical systems where we had but one earlier. Let A designate the old system, consistent with the old set of axioms and postulates. Let B signify the replacement lattice, purified of all of the fallacies proven to exist in A. In this case, no theorem in system A is consistent with any theorem in lattice B, and none in lattice B consistent with any in lattice A.

From the vantage-point of lattice A, the existence of lattice B is "an act of creation." The action of the individual mind, which generated the strong hypothesis on which the unique experiment was premised, has transformed lattice A into lattice B, to the effect that no lattice-point in B coincides with any lattice-point in A.

The problem is, that although we are obliged to say that the relevant scientist's mind "created" the conditions for existence of lattice B, deductive analysis prohibits any effort to supply an intelligible representation of the process of creation through which this result was accomplished.

For reasons already identified, the gap between lattice A and lattice B is very small. In modifying only those axioms and postulates which must be modified to correct for the results of the unique experiment, we have made the absolutely minimal degree of change possible in a deductive system: only the one or more elements of the lattice addressed so. It would be impossible to make the gap between the two lattices smaller than this deductively. Yet, in deduction, we can say nothing about that gap itself.

In that gap lies the action of creation.

That which we have just outlined, is a summation of the argument made by Immanuel Kant. Kant could not deny the existence of creation, nor the form of creation associated with the results which he associated with "synthetic judgment *a priori*." Yet, he insisted that the creative mental processes could not be given an intelligible representation.

Kant overstated his case. Had he said, "No intelligible representation of creative-mental processes is feasible within the bounds of a formal deductive logic," his argument would have been correct. He went too far, in asserting that no intelligible representation was possible; his error was that of assuming that only formal-deductive methods are capable of supplying an intelligible representation.

Norbert Wiener, John von Neumann, and others perpetrated the same absurdity as Kant did, in their doctrines of statistical "information theory" and doctrines of brain function. It is important to stress, that in none of these cases was the absurdity an innocent consequence of an honest error.

Kant was fully aware of the fact that a well-developed alternative to deductive methods existed in the synthetic-geometrical method of Plato, Cusa, Leonardo, Kepler, and Leibniz. Kant had built his career in Germany as an apostle of David Hume and the formalist Wolff, in the stated intent to eradicate the influence of Gottfried Leibniz from German universities. Even after his open break with Hume, during the 1780s, Kant adhered to his hatred of Leibniz and synthetic methods, and also hysterical hatred against the classical idea in science and fine arts generally.

Norbert Wiener was expelled from a scientific seminar at Gottingen University by none less than the great David Hilbert, for reasons of the stubborn incompetence of Wiener's scientific method. The issue was essentially the same as that between Kant and Leibniz. John von Neumann had a long track record as an hysterical fanatic on the same issues. Just as Wiener's "information theory" is trash, so is von Neumann's collaboration with Oskar Morgenstern in their *Theory of Games and Economic Behavior*. The assumption underlying each of these follies is the same which Kant asserted in his *Critique of Judgment*.

The solution to the problem of intelligible representation was already implicit in the Socratic dialogues of Plato. The Socratic method is the criticism of propositions by aid of the "hereditary principle," to the effect of showing that certain axiomatic assumptions are necessary to that proposition, and proving those assumptions to be absurd in some crucial respect.

Resuming our scrutiny of juxtaposed lattices A and B, let us assume the case in which only one axiom of A was modified to yield B. This is the simplest case which defines a deductively unbridgeable gap between the two lattices. Another name for such a gap is "discontinuity." In formal mathematics, we speak of such discontinuities; in mathematical physics, we prefer to recognize such gaps as "singularities." The slightest alteration in the set of axioms and postulates of any formal deductive system generates such a discontinuity.

The converse is also true. The appearance of a discontinuity over the span of short gaps within what is otherwise a continuous function, is experimental demonstration that some change in the lattice-work of the theorem-set apparently applicable to the state of the process prior to the discontinuity, has occurred by the time the other side of the gap is reached.

The general observation to be made, is that the process of fundamental scientific discovery is a continuous one, in the respect that one such transformation establishes the preconditions for a subsequent one. For such reasons, it is clear that the process of scientific progress is of the character of a continuous function; yet, the appropriate function which might provide us an intelligible representation of the process so defined, is one based on the successive generation of discontinuities of the form we have identified.

Leibniz had already provided me clues to solving such a problem, in locations including his *Monadology*, one among the favorite Leibniz readings of my early through middle adolescence. I was moved to attack Wiener's thesis, beginning 1948, because of my established interest in the subject of what is termed the "negative entropy" characteristic of living processes. In studying Prof. Nicolas Rashevsky's writings on biophysics, part of my work in the project of refuting Wiener's "information theory," the obvious failure of Rashevsky's otherwise brilliant work was his use of "perturbation" theories as a ruse for attempting to circumvent the fact that even his own construction of models of cellular living processes showed the function of life to be a continuous function most characterized by discontinuities.

To be continued next week.