Creativity and Secondary Curriculum

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February 5, 1988

*[Published in **Executive Intelligence Review**, Volume 15, Number 9, February 26, 1988. View PDF of original at the LaRouche Library.]*

*In Part 1 of this article, entitled, "Creativity and Curriculum in the Emerging Age of Nonlinear Physics," and published in **EIR**, Vol. 15, No. 8, Democratic presidential candidate Lyndon LaRouche wrote: "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."*

Below is the concluding section of his report, which was released for general publication by the LaRouche Democratic Campaign.

4. The Synthetic Representation

There exists, from nineteenth-century physics, a classic case of such a type of problem. In its simplest expression, this is termed a Weierstrass function, after one among Riemann's leading contemporaries, Karl Weierstrass. The same problem was scrutinized further by a student of Weierstrass, Georg Cantor.

The most important feature of Cantor's contributions is the notion that the density of discontinuities within an arbitrarily small interval is enumerable by the principle of transfinite orderings. Once I had defined the problem to be solved, as the foregoing critique of the Kant problem summarizes that approach toward a solution, my attention was focused upon the work of Cantor.

What was required was a more advanced theorem. I had determined that, contrary to [Norbert] Wiener, the proper measure of negative entropy ("negentropy") is an ordered increase of the density of discontinuities per small interval of action of a process, and entropy measured as a decrease. It was necessary to go beyond Cantor's extant work, to define the next higher-order transfinite function, the notion of rate of increase (or, decrease) of the rate of propagation of increasing density of discontinuities. This required turning back to the work of Riemann, beginning with several key papers of 1853, including his more famous inaugural dissertation, "On the Hypotheses Which Underlie Geometry."

In brief, the case is as follows.

Cusa's central discovery bearing upon methods of physical science (as reported within his 1440 *De Docta Ignorantia*), is a "Maximum-Minimum" principle which he discovered as a correction to Archimedes' work on the problem of quadrature of the circle. Essentially, circular action is the minimum perimetric action required to subtend the relatively maximum area or volume per unit of perimetric displacement. (A simple student's proof of this is available on the secondary level.)

The question thus posed is, whether or not the laws of the universe are in elementary conformity with this isoperimetric principle? If so, then the laws of the universe are implicitly derivable from the notion of isoperimetric action as physical least action. In other words, the pathway of action is always the action which represents the least action required to accomplish an effect. The refraction of light is the simplest general demonstration that this is so.

In that case, the universe is characterized by circular action acting reciprocally upon circular action during every interval of action. In that case, lines and points are generated by such multiply-connected circular action. In these terms of reference, a purely synthetic geometry, which proves everything by construction, without axioms or postulates, and prohibiting deduction, can construct the entirety of the scope of Euclidean geometry, as is the case.

Multiply-connected circular action is not an adequate construction of the entire universe. If we make circular action more general, the problem is solved implicitly. Let the more general form of least action be a uniform rate of increase or decrease of circular action: self-similar-spiral action, as might be portrayed by construction of a self-similar spiral on the surface of a growing cone.

This was the approach employed by Gauss to solve Kepler's assigned problem of rendering elliptic functions fully intelligible. The cross-section of a cone, constructed in terms of reference of the self-similar spiral, provides us, in each case, an elliptic cross-section, for which one focus of the ellipse lies upon the axis of the cone. This provides also a plane projection of the ellipse on the plane intersecting the apex of the generation of the cone. The characteristics of the series of ellipses and their plane projections, so ordered in terms of a function expressed in terms of a self-similar-spiral action, affords a general theory of these simplest forms of elliptic functions.

The multiply-connected form of self-similar-spiral action presents us with some results most relevant to the representation of continuous functions dense with enumerable discontinuities. In every instance, such a function generates discontinuities. The function is a continuous one, yet increasingly dense with discontinuities. In physical economy, such functions are indispensable for measuring the real rate of economic growth.

This defines the Gaussian complex domain in an elementary way. Least action occurs in the form of multiply-connected self-similar-spiral action. By expressing the rotating and stretching action as a locus-function, we generate the array of trigonometric representations which enable us to state these functions in what appear to be an algebraic way. This defines all real physical functions as requiring adequate representation in the form of complex functions.

The pedagogical challenge is, that this locates physical action as occurring "outside" the domain of pure and simple sense-certainty. The Gauss-Riemann complex domain shows us, that what we experience as the events of sense-certainty are projections of actions lying primarily within the complex domain. This affronts the popular belief, that our senses show us directly "what is there;" our senses supply us, instead, with an excellent and reliable set of meter-readings on what is occurring within the complex domain.

The generation of discontinuities inherent in the Gaussian complex domain threatened to become a crisis within Gauss's mathematical physics, until a first elementary solution was contributed by Lejeune Dirichlet, a solution which Riemann named *Dirichlet's Principle*. The same problem is that addressed, relative to a similar point of crisis in Fourier Analysis, by Weierstrass. Riemann generalized the work of Gauss, Dirichlet, and Weierstrass in his definition of a Riemann Surface function.

Creative-mental processes are nonlinear functions of the form of a Riemann Surface function.

5. The Physics of Creativity

There are two mutually exclusive notions of mathematical physics. The one is derived from Euclidean deductive geometry, as typified by Descartes. The other is derived from the successive work of Cusa, Leonardo, and Kepler, and implicitly from Plato's dialogues. The latter is also the standpoint of Leibniz, and also of the work of Gauss, Dirichlet, Weierstrass, and Riemann. The former is the standpoint of Gauss's leading nineteenth-century adversaries, such as Clausius, Kelvin, Helmholtz, Maxwell, Rayleigh, and Boltzmann.

In the Cartesian, or deductive model, the definition of substance, or matter, is limited to discrete particles roaming in empty space and empty time. In a deductive mathematics, no physics other than the Cartesian Euclidean model is possible. For the same reason, already shown by Archimedes' theorems on the subject of the quadrature of the circle, such a physics is incapable of tolerating explicit solutions for nonlinear processes.

In synthetic geometry, that kind of distinction among matter, space, and time is not possible; only physical space-time exists. It is for this reason, that Kepler's physics is recognized today as being a relativistic physics, in contrast to the mechanistic physics of a Descartes, Newton, Kelvin, Maxwell, *et al.* For example, no adequate form of explicit solution of any proposition in relativistic physics can be reconciled with the electrodynamics of Maxwell and his followers. Similarly, the only possible modern relativistic physics is a Riemannian physics, reflecting the more adequate treatment of Kepler's discoveries by way of the discoveries of Gauss.

Earlier, we examined the gap between two deductive lattices differing only in some particular feature of their respective sets of axioms and postulates. We then shifted our perspective, to the non-deductive, non-Euclidean vantage-point. We indicated a gap between all formal deductive lattices and those premised on constructive (synthetic) geometries. Next, we identified the distinction between multiply-connected synthetic manifolds premised upon simply circular least action, and those premised upon self-similar-spiral action.

We have now emphasized the existence of an absolute gap between all physics represented by formal deduction, and all physics represented by synthetic methods. This leads us to crucial considerations bearing upon the general representation of the mental-creative processes. The pivot of the matter in this section, is the importance of emphasizing that Kepler's physics was already a full-blown relativistic physics.

We preface the remarks on that point with a necessary observation on the ascending hierarchy of relationships among the world as represented by sense-certainty, the meaning of sense-certainty from the standpoint of a synthetic geometry based upon multiply-connected circular least action, and the view of the latter from the vantage-point of self-similar-spiral least action.

All assumptions respecting the laws of physics which are based upon formal deduction, such as Euclidean geometry, are wrong ones. Nonetheless, what our mental perceptual apparatus shows us are true shadows of real effects. The error of formal deduction is that it superimposes a wrong interpretation upon those effects. That error is implicitly removed if we but employ synthetic methods, rather than Euclidean ones.

From the highest standpoint, multiply-connected self-similar-spiral least action, there is nothing in a physics premised upon circular least action which is intrinsically false. The difference between the two is, that the latter considers only constant circular action, whereas the former considers constantly increasing (or, decreasing) rates of circular action. The higher form includes, as special cases, every proposition contained within the lesser form; but, the lesser can represent only limited ranges of special cases in the terms of the higher form.

So, we discard none of the data of mechanistic physics; we discard only the arbitrary Euclidean interpretation of such data. We discard nothing of elementary synthetic geometry in the Gauss-Riemann manifold. From the standpoint of physics, the practical difference between the two synthetic geometries is shown by the limitations of Fourier Analysis, as Weierstrass isolated the essential difference in its primitive form. Generally, we may say, the higher-order discontinuities can not be represented by any less adequate means than the synthetic-geometric construction of the Gauss-Riemann complex domain.

The established classroom customs of the recent hundred years or so have presented pedagogy with a problem in attempting to make clear the practical implications of the distinctions we have just described.

The political power of the Cartesian faction in science, as typified by Kelvin, Clausius, Helmholtz, Maxwell, Boltzmann, *et al.*, is such that the community of physicists requires all scientific propositions to be stated in the formal terms of deductive physics. The aura of mystification which surrounds discussion of topics of relativistic physics is largely a consequence of this custom. One is not permitted to say, even implicitly, that the deductive world of Euclidean formalism is flatly wrong. One is permitted to attempt to prove any experimental result, on the condition that the proof is argued in the terms of a Euclidean formalism.

Although these considerations are customarily viewed as advanced ones, way beyond the scope of most undergraduate science curricula, the implications bear directly upon the choice of advanced standpoint which the secondary school teacher adopts in defining the conceptual goals of pre-science education. As we shall indicate in a following location here, this is also essential for adequate approaches to teaching of the classical fine arts. Without this advanced standpoint, the meaning of creative-mental processes, and the bearing of this meaning upon proper choices of secondary curricula, are not clear.

The crux of the matter, for mathematical and physics instruction on the secondary level, is the proper study of the leading contributions of Kepler.

For axiomatic reasons, the Euclidean standpoint demands that cause-effect in the universe occur only in the form of direct and pairwise interactions among elementary particles roaming in empty space and empty time. This, as Newton conceded, leads us fatally to the false view of the universe, that the material universe was created by a "big bang," and has been running down, in the sense of a mechanical timepiece, ever since.

From the synthetic standpoint, the opposite is true. As Cusa elaborated in his *De Docta Ignorantia*, all action occurs as a functional interrelationship between the minimum and the maximum, between microcosm and macrocosm, between the particular and the "field." The action between particulars is determined by the efficient relationship between each particular and the "field."

The relationship between the particular and the field is defined by the principle of physical least action. The interaction between two particularities is their interaction with the field subsuming the existence of both.

Thus, if we discover the form of adequate representation of least action, all of the laws of the physical universe are implicitly derivable directly from that representation. The task of science is essentially that of discovering empirically the nature of an adequate representation of least action; at least, that is the bare bones of the matter.

The scientific authority of Kepler is broadly established empirically, by the fact that his astrophysics works, and those of his leading adversaries, such as Newton, do not. The most crucial feature of Kepler's construction of the Solar System, is his prediction of the necessary existence and destruction of a planetary body lying in an harmonically defined orbit situated between those of Mars and Jupiter. The discovery, at the turn of the nineteenth century, of the asteroids Pallas and Ceres, was a crucial-experimental proof to this effect. Gauss showed that the harmonic values of the asteroid orbits were those specified for the missing planet by Kepler.

Kepler set out to show that the existence of the Solar System was the reflection, not of pairwise actions among solar bodies, but of an harmonic ordering of the astrophysical field. In contemporary usage, the planetary orbits, with their harmonic characteristics, represent the minimum-force pathways of action available within solar space.

We might use the imagery of a sheet in which the planetary orbits are troughs, such that the planets fall into the elliptic troughs. To get out of a trough a great deal of work must be done upon them. The number of planets is limited to the number of troughs available. We might imagine the troughs each to be friction-free, and the elliptical orbits to be tipped (in a classroom model), such that the planets accelerate toward their perihelion, and slow toward their aphelion.

Such a pedagogical trick does not show us the actual laws of the universe, but it represents crudely the phenomena to be considered. The illustration is made more useful, in this way, by stipulating that the mass and mass-densities of each of the orbits are functions of their orbit's position, rather than the position being a function of the pairwise interaction among their masses.

The question is posed, what is the character of physical space-time, to such effect that the number and ordering of the planetary orbits is determined so, even, hypothetically, if no planets existed in those places? Such was Kepler's approach.

As Kepler insists, his solar hypothesis was based upon the solar hypothesis of Nicholas of Cusa, as Kepler's method was based on the "Maximum-Minimum" principle introduced by Cusa. For the rest, his chief debt was to the collaboration between [Luca] Pacioli and Leonardo, who showed that living processes were regulated by harmonic orderings congruent with the Golden Section. Hence, the laws of the universe must include the harmonic determination associated with the Golden Section.

So, Kepler constructed successive hypothetical geometrical "models" of what solar space must be. His empirical discovery was the observation that the orbits were elliptic, rather than circular. His further accomplishment was to show that elliptic orbits were consistent with the harmonic ordering prescribed, and that that harmonic ordering of orbital velocities was consistent with the best observations available to him.

Thus, action among particles is not determined by mechanical pairwise interactions among them. Physical space-time has a determining "shape," consistent with harmonic orderings congruent with the Golden Section. Hence, particles can act upon one another only as they act each upon the "field" which contains them both.

The significance of individual human existence is of the same nature, but at a much higher level of interaction.

The form of human action which is characteristic of human existence, is creative-mental activity to the effect of generating and assimilating scientific and technological progress. The primary action of the individual, is the individual's action upon society, and, through society, the physical universe we inhabit. It is the generation and transmission of such creative activity which changes the potential population-density of society, and thus changes the relative value of the behavior of every individual in society.

These notions point toward what we signify by the terms "curvature of physical space-time." Kepler was the first to measure, albeit with a fair degree of approximation only, the curvature of universal physical space-time.

This takes us immediately to a challenging proposition. Does the existence of the acting individual alter, in some way, the efficient curvature of physical space-time? In one sense, this is precisely what human existence does, especially as the effects of scientific and technological progress illustrate this. Yet, it does not change the underlying curvature of the universe as a whole. What occurs, then?

Local changes in the curvature of physical space-time occur only in the form of increasing, or decreasing the density of discontinuities per arbitrarily small interval of action. If the density increases, the result is what we term "negative entropy." If the density decreases, the result is what we term "entropy."

For this to occur, the laws of the universe must permit such effects. In other words, the laws of the universe pertain not simply to the kind of fixed curvature of physical space-time intrinsic to Kepler's founding of a comprehensive form of mathematical physics. The laws of the universe cause what Kepler portrayed, but what Kepler portrayed is not an adequate representation of those laws themselves.

We must situate Kepler's laws within the higher, subsuming domain of universal negentropy. Universal negentropy is the law of the universe. That negentropy is of the form which subsumes a physical space-time curvature of Kepler's sort as a special, universal case.

This does not suggest that Kepler did not recognize such a form of universal negentropy. Quite the contrary. He emphasized that the laws of the universe were congruent with the characteristic physical space-time of living processes, the latter the model for the notion of negentropy. He also emphasized, that this negentropic character of universal creation coincided with the effect of harmonic orderings congruent with the Golden Section. Kepler was correct, as far as he went; but, as he emphasized to those who would follow him, he left much to be completed by the scientists who came after him.

The relevant demonstration of this point to secondary students, is elementary. The metrical characteristic of any plane projection of self-similar-spiral action, is the Golden Section. Once we progress from the multiply-connected circular action of Kepler's physics, to multiply-connected self-similar-spiral action, all the relevant mystery is dispelled. Those functions which represent increasing density of singularities within the complex domain, cast shadows harmonically congruent with the Golden Section in the domain of sense-perception.

The crucial point to be made here, is the following one.

The curvatures of physical space-time on the astrophysical and biophysical scales are the same. It has been demonstrated in plasma physics, that physical space-time on the atomic and subatomic microphysical scales has the same curvature as astrophysical and biophysical space-time. My representation of the creative mental processes shows the same space-time curvature. In summary, there is this form of projective congruence among astrophysical, microphysical, and biophysical space-time, on the one side, and creative mental processes on the other.

For reasons indicated, this correspondence of mental processes to reality does not exist within the scope of mere formal deduction. It exists only in terms of the creative processes. We know nothing about the lawful composition of our universe, except from the standpoint of processes of valid fundamental discoveries so ordered.

In all four cases—astrophysics, microphysics, biophysics, creative processes—the processes are elementarily "nonlinear." This signifies that the laws of the universe can be stated correctly only if they are stated in such nonlinear terms of reference. The mere fact that some statement in a linear (deductive) mode is represented as stating a law of nature, is conclusive evidence that what is stated is not a law of nature. This does not mean that such statements are categorically false in any respect but that they are misrepresented as describing a law of nature; if they are based on rigorous experimental observations, there is some truth to them. It is merely the case that no universal statement can be made competently in a formal deductive (linear) mode.

6. The Definition of 'Reason'

It is an unfortunate fact, that common dictionary definitions of the term "reason" represent that term as a synonym for "logic." This was Kant's definition. It is important to stress the fact, that this definition is false. A policy of education based upon such a false definition of "reason," is the practical issue we are addressing.

By "reason," we ought signify the processes by means of which knowledge of the lawful ordering of the universe is secured. Those processes are nothing but the creative processes; logic, in the sense of formal deduction, is no substitute for this. On those grounds, classical education recognized, at least implicitly, that the Socratic method of Plato's dialogues is a model of reason. The Socratic method partakes of reason, but, as we have indicated, by itself it is not yet an adequate definition, merely a useful approximation.

It is important to restate our theme in this light. The function of education is to foster the student's development of his or her potential for task-oriented creative mental activity. This is accomplished, in large degree, by use of those primary source-materials, written materials, and experiments, which best represent discoverers of the past at work. By aid of these means, the student relives those processes of discovery, and by reliving them repeatedly in this way, develops a corresponding rigor. The contrast between this approach and "textbook learning," is among the points to be stressed.

The testing of students should focus upon their ability to "rediscover" such past discoveries, the capacity both to reconstruct such discoveries, and to present a coherent exposition of that reconstruction.

The critical mission in this aspect of secondary education, is to lift the student not only above irrationalism to logic, but beyond logic. The included goal is to foster an improved version of Socratic method. "This signifies that the student acquires the habit of identifying the "hereditary principle" underlying any proposition, to the effect of identifying the set of implied axioms and postulates associated with the assertion of that proposition as a proposed theorem. This signifies, in turn, that the student grasps the point that all sets of axioms and postulates are elements of an enumerable series. This is to be accomplished in the only way in which it can be accomplished, from the standpoint of synthetic method.

7. The Fine Arts

Since classical Athens, those harmonic orderings which are congruent with the harmonics of healthy living processes have been the mark of natural beauty. The precondition for the student's comprehension of aesthetics is rendering the idea of natural beauty an intelligible one, derived from reason as we have defined reason above.

To this purpose, the initial study of biology in secondary schools should echo Luca Pacioli's *De Divina Proportione*. Once the student has progressed to the level of propositions of the tenth through thirteenth books of Euclid's *Elements*, the student is prepared to verify Pacioli on the harmonic ordering of living processes. The work of Albrecht Dürer on the human form, and the work of Leonardo and Dürer on the harmonic ordering of the most natural motions of the body, is to be incorporated at this point.

Life is beauty, and deadness and decay are ugliness. This is the root principle of natural beauty.

This aids in establishing the congruence of truth and beauty. The notion of that congruence affords the student a rigorous basis for comprehension of artistic beauty. The student is enabled to recognize, that the distinction between natural beauty and a work of classical fine art, is that although all classical fine art is enslaved to the principle of natural beauty throughout, something distinctively human is added. This human quality added, is the distinction between natural and artistic beauty.

This is readily demonstrated for painting, by reference to Leonardo's discoveries in perspective. Leonardo superseded linear, Albertian projective perspective with perspective based upon reflections of a convex spherical mirror. This is demonstrated most conveniently in Leonardo's own work, and the work of Raphael. The same principle applies to artistic beauty in architecture.

It can be shown, that the crucial feature of these works of art, which define their artistic beauty, is the degree to which they go beyond natural beauty without violating it. It is demonstrable, that the artistic composition adds singularities—such as those determined by the interaction of the light sources in Leonardo's "Virgin of the Rocks"—to the effect of marking the distinction of artistic beauty.

The same is demonstrated for music, although this subject is more sophisticated than the subject of the plastic arts.

This requires a critical view of Kepler's treatment of musical harmony. From the standpoint of the Gauss-Riemann manifold, we are able to correct Kepler's construction, and to show that the only natural musical scale is the well-tempered one. However, this shows that that is no mere, note by note scale-progression, but that the scale-progression is determined by Keplerian harmonic intervals.

It can be shown, to more advanced students, that the method of voice-training termed *bel canto* is the only natural manner of singing, that any other mode of voice-training is relatively ugly and inefficient. From this standpoint, the interaction of the well-tempered system and the characteristics of singing-voice registration defines the way in which classical polyphony was composed by such as Bach, Mozart, and Beethoven.

Throughout, the point is to render the principle of beauty intelligible. By showing, contrary to Kant, that there is an intelligible standard of both natural and artistic beauty, we define the congruence of truth and beauty as the essential quality of classical fine art.

The importance of classical fine-arts curricula in the secondary schools lies precisely here. There are two facets to this. First, there is the fact that the essential feature of the formal composition of artistic beauty is the exercise of the creative-mental faculties. The function of classical fine art is to celebrate joyfully the creative mental powers of the individual. The second aspect is the emotional one.

The human emotions are of two qualities. In the lower part of our natures, emotion is erotic hedonism, in the sense of irrational motives of lust, greed, fear, hate, and rage. In the higher part, our motives tend toward what the New Testament Greek names *agapē*: the quality of love of God, love of mankind, love of truth, and love of beauty.

The latter quality of emotion is typified by the reference to "tears of joy." This quality of emotion is essential to creative-mental activity. It is the emotion we experience as the reward of discovery. It is the emotion which energizes, which sustains our powers of concentration in creative work. It is the characteristic emotional correlative of the creative-mental processes, without which the creative processes can not be sustained.

It is judgment informed by this guiding quality of emotion, which is true morality. The emotional quality associated with love of God, love of mankind, love of truth, and love of beauty, is the root of what we rightly define as the strength of moral character of the individual. It is the association of one's notion of personal identity, happiness, and self-interest with those actions which cohere with a heightened sense of such emotional quality, which is the essence of a strong moral character.

From this vantage-point, the artistic beauty of great classical tragedy, and of classical poetry, is recognized.

The establishment of the complementarity of scientific creativity with the intelligibility of artistic beauty, is the essence of a classical humanist secondary curriculum.

8. History as Science and Art

The function of study of history, is to situate the individual's sense of personal historical identity. When this is accomplished, the student says of his or her choice of adult life, "This is the profession I shall adopt to make my contribution to mankind." The student locates his or her personal identity in mankind, as a microcosm contributing to the shaping of the future of the macrocosm. "I shall discover," or simply, "I shall contribute," are the primary objectives served in the teaching of history from that vantage-point.

The general objective to be reached, is to afford the student a sense of the meaningfulness of his or her individual existence in the universal history of mankind. This is made realistic for the student, by reference to the history of the nation, and reflection upon that nation's proper contribution to the shaping of history for the advantage of mankind.

This requires that the sense of history be made concrete in other ways.

Classical tragedy intersects here. A grasp of the principles of classical tragedy affords the student a reference-point for study of history. Concrete history is presented as a real-life form of classical tragedy. The student understands past history in the same general manner the internal history of scientific progress is mastered. One must employ classical primary source-materials and related facts to place oneself, at the same time, in the shoes of the leading figures and ordinary persons in the period of past history considered. One must relive, in that degree, a sense of being the leader who succeeded or failed, and so forth.

In this way, the student is led to acquire a sense that universal history has laws akin to scientific laws.

By bringing history since approximately classical Greece up to the present—from whence we came, and by what means we arrived at our present condition—we instill a capacity for responding effectively to the challenges of present history as present history.

Art is morality, and the physical sciences define the powers to which morality has access for meeting the challenges before it.

A student who has completed such a process of fostering of his or her potentials of character and creative thinking, has been afforded everything secondary education should provide. He or she is better equipped to meet the challenges of adult life than the most excellent sort of any different approach to education.

Since the frontiers of science and technology today, are all focused upon nonlinear processes, no different approach to education could be an adequate one.