Economics and population: the principles of technology

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My discovery of what is now termed the LaRouche-Riemann method dates from 1952. In brief, a study of the work of Georg Cantor permitted me to gain more efficient insight into the 1854 habilitation dissertation of Riemann, *On the Hypotheses Which Underlie Geometry*. That dissertation showed me what has proven a feasible approach to determining the causal relationship between advances in technology and consequent rates of real economic growth.

Through teaching that method of analysis, I was fortunate to attract gifted students who became my collaborators, including a number with outstanding qualifications in matters pertaining to physics. Our combined interest in both economic science and also in matters on the frontiers of the contemporary plasma physics, led to a deeper appreciation of the exact connections between Riemann's 1854 habilitation dissertation and an 1859 paper of Riemann's, in which latter paper Riemann predicted the necessary production of acoustical shock-waves in experimental configurations of certain cardinalities.

That latter paper, denounced by British physicists up to the close of the last century, has been proven decisive for solving problems of rocket design and related matters of aerodynamics. It has had other crucial importances. It was the basis on which Erwin Schrödinger launched his successful attack on the electron's inner secrets; it is also crucial for the design of the triggering of devices such as hydrogen bombs; and it is crucial for mastering such frontier matters as the physics of relativistic beams. The most important accomplishment of my associates and myself, in connection with the topics of this paper, has been to show the necessary connection between the cited 1854 dissertation and the 1859 discovery. It is that work in the domain of scientific methodology which governs the more recent advances occurring in the elaboration of the computer applications appropriate to the LaRouche-Riemann method.

The bulk of the published work on the physics side of the development is being provided by a team headed by Dr. Uwe Parpart and Dr. Steven Bardwell. Here, I shall stress features of the collaboration which are more emphatically my own particular contribution, limiting myself to the practical implications of an oil-for-technology collaboration between Mexico and the United States.

I now direct your attention to the axiomatic features of the problem of technology generally. With an eye to the necessary interconnection between petroleum and nuclear-energy development at this juncture of world history, I summarize the necessary proofs for a conception best labeled potential relative population-density. This conception, I shall demonstrate, is the sole premise of economic science.

I shall now argue that this notion of potential relative population-density is the fundamental metric to be employed for determination of the value of terms of mathematical functions describing economic processes, a value which can be rigorously determined without regard for any existing market determination of prices. I shall demonstrate how economics, defined in this way, directly intersects and enriches the specialty known as thermodynamics. It is in that connection that the unique appropriateness of Riemannian physics for economic analysis is situated. I shall limit myself only by regard for the fact that most of you are not physicists. This will be no impossible difficulty, since the essential points can be demonstrated efficiently to any group of persons familiar with the problems of technology from the vantage point of economics studies.

I shall be profound, but I believe I shall also succeed in being simple.

I contend that all science begins with a personal comprehension of the implications of mortality. The awareness of our mortality leads us away from hedonistic values. We do not eat less, go naked, or adopt vows of chastity on this account; rather, we place the ephemeral moments of necessary consumption into proper moral perspective. We think of the outcome of our mortal lives both for the span of the present times and the duration of our posterity over generations to come. We adopt a purpose for our lives, and the development of our talents according to that adopted purpose. In that way, we ascend from the hedonistic "Inferno" described by Dante, upward toward the higher rationality described in the "Paradise" canticle of that same *Commedia*.

This world-historical outlook on the meaning of our individual lives is the form of conscience out of which rationality is developed within us. We are obliged to govern our judgment and actions in life according to an estimation of the outcome of our acts and acts of omission. We are obliged to discover some lawful ordering of the connection between our actions and the consequences over the larger, world-historical span and duration of reality in which we properly locate our true identities.

This point of view leads to the emergence of the scientific world outlook generally. It leads directly to discovery of the fundamental principles of economic science.

Insofar as we are concerned, in the narrowed sense, with the material side of human existence, we measure our individual life's value in terms of our contribution to humanity over the span and duration I have indicated. That desire to make our individual lives of moral worth confronts us with a twofold question.

First, how can we measure in advance what will be in fact a contribution to mankind? Second, how can we predetermine some efficient causal connection between our choices of personal action and the desired quantity of consequence?

The answer to those two questions is to be found in the following steps.

The general consequence of human activity is the production of human existence. The question of the consequences of our actions is the way in which those actions increase or diminish the power of our species to reproduce human existence. This power is expressed in first approximation in terms of the number of individuals which can be self-sustained on an average square mile of habitable land.

This encounters the practical difficulty, that not all land is equally habitable. Natural and man-altered conditions make one bit of land more or less habitable than another. We seek to express a power, a power whose results are proportional to the different qualities of inhabited land. Therefore, the power's results are relative to those alterable conditions. We must measure the power to effect a relative population-density of self-sustaining populations.

This confronts us with a further practical difficulty. It is not the number of persons self-sustained presently on land which we must measure. We measure, instead, the potential relative population-density.

This is not an imitation of the census projections used for the cruder forms of animal ecology. We are not considering a case in which some external means or a hereditary range of behavioral potentials enables a certain number of biological individuals to exist on an area of habitable land. The population-density effected expresses a culturally developed power of those individuals.

The formal difficulty is that human existence cannot be defined in terms of mere biological necessities, as we might define the biological necessities for an animal or plant species. The more powerful the individual becomes as culture advances the technology, the greater the cost of producing an individual adapted to employ that technology.

For example, as the technology advances, the necessary period of education and related development of youth prior to their entry into the labor force is advanced. The cost of producing a new productive member of the labor force qualified at the university level is obviously greater than in a child-labor-oriented mode or relatively poor agricultural production. This increased cost of developing the individual places a greater value on the longevity of the individual. A relatively advanced culture requires a more advanced and costly form of hygienic expenditure and health care. More advanced technology requires greater expenditure of time and production output on those forms of leisure which nourish the creative-mental powers.

Wages are not an arbitrary matter of negotiations between employer and employee. The proper minimum wage is determined by the level and rate of advancement of technology of production.

The considerations we have just outlined are indispensable but remain rudimentary, inadequate. We must advance another qualitative step.

We have begun to outline the answer to the first of our two questions. We desire to increase the power of future populations in term of potential relative population-density. We have not yet circumscribed the full meaning of that objective, but we have at least located the raw material of the idea to be refined. We must postpone the refinement until we have turned our attention for a moment to our second question.

If we are to know the consequences of our individual mortal life's self-development and action, we must adduce some reliable principle of causality linking our actions to changes in the potential relative population-density. *We must be concerned, therefore, to discover how increases in potential relative population-density are ordered.* This brings us to the outer aspect of the interconnection between technology and thermodynamics.

In the early life of our species mankind lived in the savage mode of existence broadly analogous to that of baboons, and had a global population potential of a corresponding quality. Today the human population exceeds 4 billion persons. Unless President Carter's genocidal *Global 2000* program of mass murder is continued, the population will reach 6 billion or more by the close of the century.

On condition that we deploy fully fission energy potentials, and also develop rapidly fusion energy potentials, the present general range of technology at our command would permit a global population of tens of billions on a more comfortable basis than we find in the present population-density of Belgium.

During the next century, unless our species behaves as a collection of idiots, we shall be colonizing nearby space. My proposal to begin the "earth-forming" of the Saturn moon known as Titan beginning the geophysical year 2057 A.D. is an eminently realistic proposition. We shall have major stations orbiting near Earth. We shall move in ferries to and from these stations and the surface of our planet. Immense fusion-powered spaceships, accelerating to tremendous velocities, will be capable of carrying stations to nearby planets and their moons. By the end of the next century, human exploring parties should have visited the vicinity of some nearby star.

Any society following a zero technological growth policy has doomed itself to die. If that society chooses to revert to a simpler level of technology, it merely accelerates such decay with accompanying massive genocide.

So, the ordering of the population-density of our species can be traced over a span from the Pleistocene to just over a century ahead of our time.

In studying the various known modes of human existence up to the present time, we are able to reconstruct the characteristic ecological features of those cultures in terms of the mode of production of life. These modes can be ranked in ascending order of potential relative population-density. The correlative of such advances in technology is chiefly the twofold increase in the amount of average energy per capita required for each mode of production. Not only does the required energy per capita increase, but this increase proceeds more rapidly than the associated increase in potential relative population-density. In the language of the secondary school student of chemistry, it appears that advances in technology correspond to increases in the per capita "reducing power" of cultures.

This brings us to the crucial question of economic science. How do we define the interrelationship between thermodynamics and technology? How do we define the sort of mathematical function in which thermodynamics and technology are equated in anything but the nominalist sense of mere numerical analysis? This problem obliges us to adopt the physics of Bernhard Riemann, rejecting the opposing views of Descartes, Newton, Cauchy, and Maxwell. It is only from the standpoint of Riemann and his preceding co-thinkers that we are able to define energy rigorously in the terms required to equate it to ordering of technology.

To develop this point for the non-mathematical participant in this conference, something equivalent to the following pedagogical approach is required.

At first approximation, our inspection of the history of technology focuses our attention on such facts as the development of animal husbandry, an advance over hunting and gathering. In a similar way, we consider the development of simple gardening. In both instances, our attention is attracted first to the fact that the amount of usable energy per square mile is increased by these developments. We rightfully generalize from those two cases, to observe that as we proceed toward modern cultures, it is the development of so-called artificial energy sources, apart from captured sunlight currently inmpinging on the Earth's surface, which increases the usable energy per capita to make possible increases in population-density.

In that first-approximation view, it appears sufficient to measure energy in scalar units such as calories or watts. Looking at the matter more closely, we are soon obliged to reject what may have appeared to us to have been a natural, unavoidable way of thinking about energy. We are obliged to reject the commonplace belief that energy exists in the universe in a form designed to be measured in units such as calories or watts. Energy, we are obliged to recognize, is much more interesting.

We shall make two levels of correction in our initial view of the significance of the development of simple gardening. The first correction is more obvious, but it contains the germ of the notion which leads us soon enough to the second, more profound correction.

The case of simple gardening obliges us to think about energy on three levels. First, we consider the total number of watts of energy impinging on an average square mile—and a pitiful amount it is. Then, we consider the portion of that total energy embodied in the plant life on the garden. Finally, we think of the portion of the energy used by plant life actually delivered for food and fiber of human consumption. We simplify this picture by examining energy systems of technology in a twofold way. We compare the total energy-throughput of the productive process with the portion of the energy-throughput which performs the desired useful work as an end result. The first, the total energy, we term conventionally the total energy of the system. The second, the energy expressed in the useful work accomplished as an end result, we term the relative free energy of the system.

What has occurred in the emergence of simple gardening is an increase in the ratio of relative free energy to the total energy of the system on which human existence depends.

We must speak of relative free energy, rather than simply of free energy. The way in which we define free energy is determined by the way in which we define net work done.

Since the question of causation being explored here is the lawful ordering of advances in technology, it is the advancement of technology (or, the same thing, the advancement of potential relative population-density), which is the only acceptable definition of net work done. Therefore, for economic processes, the free-energy component of the system is limited by definition to that margin of net work done in increasing the potential relative population-density of practiced technology of production.

We treat the total energy-throughput of production as defining the total energy of the system. It is the ratio of free energy, as we have defined it, to the total energy of the system which becomes the key parameter for our empirical researches.

The importance of using that free-energy ratio, and not some other possible definition of free-energy ratio, is demonstrated by considering the case of "zero technological growth."

Any technology defines aspects of nature as altered by mankind as "raw materials' " for essential production. Broadly speaking, such raw materials are relatively finite in extent. Although the absolute magnitude of such resources may be adequate, the amount of such resources which may be exploited at acceptable social costs of production is always relatively finite.

Consequently, even if a society were to maintain a fixed or even a reduced population, the continued existence of that culture depletes "raw materials," raising the social costs of production in a way which converges upon a rise of costs of production above the equivalent value of product produced. Therefore, any society following a zero technological growth policy has doomed itself to die. If that society chooses to revert to a simpler level of technology, it merely accelerates such decay with accompanying massive genocide. The potential relative population-density falls. When the potential falls significantly below the level of the existing population, famine, epidemic, and so forth cause a twofold effect: a genocidal shrinkage of population accompanied by cultural devolution.

For that reason, the "appropriate technologies" doctrines recommended to developing nations are inherently genocidal policies more savage in their consequences than the Nazi regime imposed upon the conquered territories and populations of wartime Europe. Similarly, the "small is beautiful" and related "environmentalist" doctrines are nothing but a prescription for mass murder on a vastly greater scale than the Nazis accomplished.

The same can be said for the opposition to deploying nuclear technologies. Without adding more than 5,000 gigawatts of nuclear process heat to world capacities over the course of the coming two decades, hundreds of millions, perhaps billions, of human beings will die—a genocide potentially a hundredfold greater than that perpetrated by Hitler's regime.

To maintain a culture at a constant level of potential relative population-density, a certain amount of technological progress must occur. The rate of progress required for this purpose must offset the increased materials costs intrinsic to using technologies for materials being relatively depleted. This portion of the increment in technology deployed is not net work done, is not free energy. It is an integral part of the cost of maintaining the total system of production in a condition equivalent to *status quo ante*.

It is useful at this point to emphasize that the indicated free energy of the system of a national economy is in mapping correspondence with a properly defined net operating profit of such a national economy, treating that economy as if it were a single agro-industrial firm. If we can assume that all of this net operating profit is converted into relative advancement of the productive technology of the society, such investment practices represent the required realization of free energy.

Now, let us return to make our second modifying statement concerning the illustrative case of simple gardening.

We warned that we are engaged in overthrowing the commonplace notion that energy can be measured fundamentally in terms of scalar units of counting, such as calories or watts. Now, we emphasize the point that plant and animal food do much more than merely to concentrate solar energy. They are biological processes which transform indigestible sources of inorganic energy into the form of food. These processes transform low-grade inorganic energy, of low free-energy ratio, to high-grade organic energy, of a relatively high free-energy ratio. It is not the number of calories of solar radiation embodied in food which is crucial, it is the chemical organization of foodstuffs into forms of organization of energy which are relatively high in free-energy ratio with respect to the processes of human metabolism.

This example implies the kernel of Riemannian physics. In place of scalar notions of units of energy, we have insisted with aid of illustrations that it is the free-energy function of processes interpreted thermodynamically which defines the fundamental significance of energy. We are insisting, as Riemann does in his 1854 habilitation dissertation, that the definition of net work done in the universe is the work of transforming physical processes from processes of relatively lower to relatively higher orders of organization. To use specialist terms, the correlative of such transformations is, in terms of reference of physical space topology, an increase in the density of singularities. That same correlative is otherwise expressed in thermodynamics as leaps in the free-energy ratio.

By combining the notions of organization peculiar to physical-space topologies with functions in terms of free-energy ratios, we define the required general form of solution to the deterministic problems of the science of technology. This proper fusing of hydrodynamics with thermodynamics defines hydrothermodynamics, the necessary form of the science of technology.