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Entropy and action principle for the enlightened development

Suresh Chandra Tiwari,
Institute of Natural Philosophy, Varanasi and Department of Physics,
Institute of Science, Banaras Hindu University, Varanasi 221005 , India
Email id vns_sctiwari@yahoo.com

Modern development heralded by the Industrial Revolution is predominantly a Western world-view. The role of science and technology has enjoyed undisputed supremacy in this model of development. Principle of energy conservation, and energy as a defining element began to take the shape of a conceptual framework for this model at the beginning of the last century. However, within few decades the question of adequate energy sources to satisfy the growing needs of the human society on the planet Earth became central among the scientists. Nuclear energy, i. e. Spin-off peaceful use of nuclear weapon technology, emerged as one of the important sources of energy. Unfortunately, the uncontrolled energy consumption in the developed countries led to enormous adverse impact on the Nature: environment, ecology, climate, and the health of the earth and oceans. The idea of sustainable development as a gradual variant of the modern development was advanced. Though political, social and economic aspects lord over this idea my concern is a scientific one. From the scientific point of view it is inexplicable that the conceptual framework based on energy has remained unaltered; renewable energy, alternative energy sources, and energy for sustainable developmen testify to the continued hold of traditional energy framework. The aim of the present article is to address following questions. Is modern development fundamentally flawed? Does there exist a compelling reason to seek an alternative framework than that of energy?

It has to be realized that consumerism and high-technology based development have very little to do with the scientific truth. Public understanding of science is almost nil, scientists have alienated themselves from the pursuit of scientific truth, and majority of scientists fail to distinguish science from technology. The over-all result of this malady is that the intrinsically exploitative nature of the modern development is not recognized. Profound ancient Upanishadic wisdom shows the path for, what I call, enlightened development. Materialistic world, animate and inanimate, human beings and animals, all are the manifest forms of Paramatma, and human life is meant to serve the whole of the Universe, i. e. the manifest form of the Brahma. Self-realization is a process that crucially depends on the least disturbance to the rest of the Universe; the highest state of this process is the enlightened state. Isavasyopanishad teaches the balance between the worldly knowledge (avidya) and the other-worldly knowledge (vidya) for the self-realization or for attaining the absolute truth. A natural question arises whether this wisdom makes sense in the light of modern science. Let it be clearly stated that vidya is beyond science; science deals with avidya. However the Upanishadic way of balanced living demands the knowledge of science or avidya in equal measure. Therefore the question becomes as to a scientific framework compatible with the Upanishadic wisdom. More than two decades ago contemplating on this question it occurred to me that perhaps entropy and action principles could

serve this purpose, and later a tentaive suggestion followed in [1]. Recently this idea in a definitive form has been put forward in Chapter 7 of [2].

To comprehend the full import of the idea it is necessary to present a brief discussion on the law of energy, the thermodynamical principle of entropy, and the principle of least action. The concept of energy and the law of conservation of energy evolved rather slowly. A physician Robert Mayer in 1842, and five years later independently physiologist Hermann Helmholtz gave the law of energy. Historical evolution of the energy law is nicely explained by Max von Laue, physics Nobel Laureate, in [3]. According to Einstein this essay has a lasting value, and recommends it to be made easily accessible to the students [3]. von Laue makes an important remark that special relativity of 1905 recognized that energy had inertia, and that culminated to the concept that 'mass is nothing but a form of energy'. He had in mind the laboratory experiments on the electron-positron annihilation to photons. Ernst Haeckel, who was a Professor of Zoology, in his book written in 1898-99 asserts that the law of substance is the supreme law of nature [4]. Here the law of substance is the combination of the chemical law of conservation of matter and the physical law of conservation of energy.

In the monistic philosophy of Haeckel , the law of substance and the monistic biogeny based on Darwin's theory of evolution through natural selection, are the key elements. He rejects what he terms as the three central dogmas of metaphysics: God, freedom and immortality. Discovery of DNA molecules and the proposition that the basic unit of intelligent life is a gene would seem to revive Haeckel's monistic philosophy in the modern age. Living organisms and human beings are nothing but robotic genes or gene machines. Though DNA molecules as such have a short life span, in the form of their copies they live for hundreds of million years. Thus energy, inertia and machines constitute the unified reality of the Universe in this philosophy. Obviously, if a man is just a machine, the moral and ethical concerns are meaningless. Not only this, there is nothing artificial in artificial intelligence or artificial micro-organisms since everything is machine. Therefore, the objections raised by the philosophers like Karl Popper or mathematician-philosopher Roger Penrose invoking natural life and human consciousness become superfluous [5, 6].

I think the self-contradiction in this kind of monism is self-destructive: utilitarian approach to the natural resources contradicts monism, and the self proclaimed supremacy of the monistic thinkers contradict the basic premise of automated machine. Conscious nonalgorithmic judgment from a monistic philosopher should have no place in this philosophy; claiming monism but retaining duality amounts to a hypocrisy that ultimately proves to be self-destructive. A new argument based on transcendence [6] demolishes the extreme monism of machine paradigm.

Chemistry Nobel Laureate Nikolai Semenov in a well articulated article underlined the significance of energy for modern development [7]. The essence of his thoughts remains relevant even today, therefore we quote from it : " ... the factor of decisive importance for the development of industry, the level of agricultural production, and the way of

life of men is the availabity of energy, particularly of electrical energy. If it were possible to provide any desired amount of electrical energy to serve the needs of men at any point on earth, then – given an adequate organization of society – the well-being of everybody everywhere could be raised to any reasonable level. At present, the average energy available on earth corresponds to only 0.1 kilowatt installed capacity per capita. This is very little."

Remarkably Semenov's typical development thesis seems to be at work even now; one could see its imprint on the UN categorization of developed, developing, and least-developed countries. Though the whole world is vying to become developed in this sense, has it ensured well-being for all? No. Now, to save mankind from extinction 'Save Earth', 'Protect Environment' like slogans are raised, but the basic framework of energy based development is not questioned. Curiously Semenov predicted synthetic polymers as the materials for future and urged for their manifold production. Today, synthetic polymers have proved to be the biggest threat to the environment. The lesson is that advanced technology for the development is not necessarily beneficial for the human society in the long run. Pure scientific logic would have explored the role of entropy in the machine-centric philosophy and unbridled application of advanced technology for human needs recalling the origin of entropy in connection with the mechanism of heat engines. To my knowledge, no thinker has analyzed modern development from this angle.

The concept of entropy and the second law of thermodynamics could be found in any good book on general physics. In the well-known textbook [8] Chapter 22 is devoted to the first law of thermodynamics and Chapter 25 explains the entropy principle. The main point is that the natural phenomena of heat can be understood in terms of heat energy and the law of conservation of energy. A thermodynamical system is a macroscopic system consisting of a large number of microscopic constituents, e. g. molecules, and the sense experiences of coldness and hotness of the system could be quantified by a physical quantity temperature. If two bodies at different temperatures are brought into contact heat energy exchange between them is a thermodynamical process and the equality of the temperature defines an equilibrium thermodynamic state of the combined system. The first law is incapable to explain as to why heat energy flows only from a hot body to a cold one and not vice versa. Another question is that, in principle, mechanical work or energy can be converted completely into heat, but no practical heat engine can completely convert heat to work. Physical understanding to explain them is developed introducing the idea of reversible and irreversible processes, and a new thermodynamic variable entropy. In the most efficient ideal Carnot heat engine each process of the operational cycle is reversible, and all the available heat is converted into work. In any other practical heat engine the amount of converted heat decreases or according to Clausius the entropy increases. Clausius relation defines entropy in terms of heat energy divided by temperature, and the second law of thermodynamics in the simplest form is the equality of entropy for the reversible and inequality for the irreversible systems. Textbook statement [8] is, "A natural process that starts in one equilibrium state and ends in another will go in the direction that causes the entropy of the system plus environment to increase". Entropy is also associated with disorder. The example of a stirred coffee cup helps picturing this relation.

It is clear that energy law is necessary but not sufficient to explain the observed phenomena in nature. Returning to the present theme, almost all energy use in the modern development involves irreversible processes, and hence enormous entropy production. Should an ideal development model be not like a Carnot engine? Energy consumption must be such that it produces the least entropy. Law of entropy, however does not restrict the amount of energy used or consumed. It is natural to investigate the principle of least action towards this objective.

The unit of action is that of the product of energy and time. Historically the principle of least time first appeared in optics: a light ray travels from one point to another in such a way that the time taken is a minimum. Reading the monograph [9] that coordinates , "the historical, mathematico-physical and philosophic aspects of variational principles" would be a rewarding experience. Last chapter in this book places this principle in the broad perspective of natural philosophy. A simple example illustrates the content of this principle: a material particle moving from one point to another takes the path that satisfies the minimum action condition. The action was defined by Maupertuis as the product of mass, velocity and distance; it is the product of Lagrange function, i. e. the difference between kinetic energy and potential energy, and time in the Lagrange's formulation of mechanics.

Action principle has played a significant role in classical and quantum field theories and symmetries and conservation laws in physics. In contrast to differential equations that use the idealization of infinitesimal time changes, the action principle is an integral law involving finite time interval. Scientists speculate on teleological implications for this reason: a particle at the beginning of its motion predetermines the actual path from among the possible paths to reach from one point to another. Max Planck not only proposes teleological interpretation he argues for the existence of the Supreme Being based on the action principle. Authors [9] criticize this view, however Planck's assertion that the energy law is contained in the action law is important in physics.

Let us seek extension of this principle for a new development model.Keeping the quantity of action fixed there are two possibilities: (a) large amount of energy and a short time interval, and (b) small energy and long time interval. A little reflection would immediately show that (a) defines modern development. One may envisage (b) for energy utilization or consumption in life-style, agriculture, and building homes, thus the minimum entropy principle combined with energy law constrained according to (b) of the action offers a radically new model of development. In fact, energy consumption at a slow rate implies almost thermodynamical equilibrium at each instant of time that approximates to a reversible process and minimum entropy change.

It may be of interest to know that Helmholtz sought to include thermodynamics in the principle of action, and Planck claimed it more emphatically [9]. A profound, but not widely recognized, idea of Physics Nobel Laureate L. De Broglie is that the principle of least action is a particular case of the second law of thermodynamics [10, 11]. He

defines entropy of a particle postulating the relation that entropy/Boltzmann constant equals action/Planck constant. Though theoretical physicists are studying various notions of entropy to get a breakthrough in the quest for unified theory of fundamental interactions, it seems the import of de Broglie's work is not appreciated. A new insight on the unifying picture of entropy and action principles [10] has a potential to give a different direction to unification other than the Standard Model. In the context of an alternative paradigm of development energy-entropy-action framework in the light of [10] is stated in the form of following proposition.

Enlightened Development : All human activity including the life-style that produces the least entropy, both locally and globally, defines enlightened development. Relative state of the enlightenment is determined by the quantity of the energy utilized or consumed for a given fixed value of action by the time interval; the best one is that maximizing the time interval.

The compatibility of this model with the Upanishadic wisdom is the reason to term it enlightened development. It is true that the storm of fast paced modern development in the age of information revolution hardly has any place for the light of an earthen-lamp of the enlightened development. Nevertheless re-thinking on the basic needs of human beings, and the application of scientific knowledge guided by the Upanishadic wisdom hold promise for this development paradigm in practice.

Recent disaster caused by the burst of a hanging glacier in Chamoli district of Uttarakhand made me to reflect upon my experiences in the aftermath of supercyclone in Orissa [12] and earthquake in Gujrat [13]. Melting of glaciers is a natural process just as cyclones and earthquakes are, however the question is why they assume the form of calamities. I believe entropy principle unequivocally and forcefully rejects hydoelectric power projects and big dams in the Himalayan region. The phrase "environment -friendly" is no more than a euphemism for the exploitatiove development agenda. Another point that deserves attention is that of the plastic/metallic waste dumped by the tourists at tapovan glaciers for past few decades. Note that a pilgrim is not a tourist. A tiny defect in the glacier, in view of nonlinear equations of fluid flow and heat transport, may develop to huge sudden bursts in an unpredictable manner. A thorough study along this line of thinking is suggested. It could be of utility for mitigation plans for future keeping in mind that any technological intervention required has to be kept minimal.

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