

SUNDAY, AUGUST 23, 2009

Indigenous Epistemology and Science: Some Parallels and Contrasts with Neoclassical Theory(NT), Chaos Theory(CT) and Dialectical-Materialism(DHM)

Indigenous Epistemology and Science: Some Parallels and Contrasts with Neoclassical Theory (NT), Chaos Theory (CT) and Dialectical-Historical Materialism (DHM)

Presented at the 16th Congress of the IUAES, Kunming, China July 26-31

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"If the construction of the future and its completion for all time is not our task, all the more certain is what we must accomplish in the present; I mean, the ruthless criticism of everything that exists—the criticism being ruthless in the sense that it neither fears its own results nor fears conflict with the powers that be."

(Karl Marx, from Letter to Arnold Ruge, 1843)

Introduction

In his extensive treatise on “Native science” Gregory Cajete notes that in “all” Indigenous languages, there is no word for “science”:

“In Native languages there is no word for ‘science’ nor for ‘philosophy’, ‘psychology’ or any other foundational way of coming to know and understand the nature of life and our relationships therein. Not having, or more accurately, not needing, words for science, art, or psychology, did not diminish their importance in Native life. For Native people, ‘seeking life’ was the all encompassing task. While there were tribal specialists with particular knowledge of technologies and ritual, each member of the tribe in his or her own capacity was a scientist, an artist, a storyteller and a participant in the great web of life.”[1]

That begs important questions for some, like Thomas S. Kuhn[2] , one of the most frequently consulted and cited authorities who wrote on the nature and history of science[3] : If certain cultures, say Indigenous cultures (not discussed by Kuhn) do not even have a word for science, how could it be possible, no matter what their purported achievements, that what they were doing that yielded those achievements, could be considered “science”? Can we arrive at a comprehensive and objective definition of “science” that transcends culture, who is doing the defining, his or her interests or motives in doing science, and the paradigm he or she employs in arriving at the definition? Or, are we stuck, like a blind person trying to define and give an image of the totality of an elephant in the abstract, by simply feeling and listing its separate parts or aspects?

Albert Einstein noted that the business of science is reality. One definition of science has to do with the purported goals of science versus non-science. Science is that which seeks not simply facts or “knowledge” in some abstract sense, but seeks to discover of the essences under the surfaces of phenomena of an objective reality, and, the ultimate laws governing those phenomena and aspects of that reality. But that notion of what is science leaves us in a dilemma: Since old notions of the essences of and even laws governing, various phenomena, discovered in the past by what was then considered “science”, are often challenged, modified or even refuted by new notions about the essences of and laws governing those phenomena, then can we ever have “science” since one of the essential purposes of science is to continually challenge and test its own notions and conclusions to find new and more universally valid ones? Kuhn has an answer for that dilemma that is somewhat tautological. He notes that science is that which builds on a foundation of what was generally considered to be science that preceded it, and is not dependent upon how fixed and universal are its purported conclusions about phenomena, but on the methods, approaches, tools, standards, validity tests, and paradigms employed to arrive at those notions and conclusions. Indeed for Kuhn, the term “science” appears to be more of a noun [4] than a verb or adjective although at times he did recognize science as a process. Kuhn appears to see science more as a “constellation of facts, theories and methods collected in current texts”[5] ; and his views sometime border on pure tautology.[6]

Yet Kuhn also went through a bit of a change between the first and third editions of his essay. In his original 1962 first edition, he makes the following remarkable statement:

“But only the civilizations that descended from Hellenic Greece possessed more than the most rudimentary science”[7]

I say that this statement of Kuhn is remarkable because his essay has nothing about views, approaches to or definitions of, science, not from the “Classical” or Eurocentric sources and perspectives. The closest he gets to exploring that non-Eurocentric approaches and discoveries might have also been “science” and possibly advanced over some contemporary Eurocentric contributions is in the following:

“In recent years however, a few historians of science have been finding it more and more difficult to fulfill[sic] the functions that the concept of development-by-accumulation assigns to them. As chroniclers of an incremental process, they discover that additional research makes it harder, not easier, to answer questions like: When was oxygen discovered? Who first conceived of energy conservation? Increasingly, a few of them suspect that these are simply the wrong sorts of questions to ask. Perhaps science does not develop by accumulation of individual discoveries and inventions.

Simultaneously, these same historians confront growing difficulties in distinguishing the ‘scientific’ component of past observation and belief from what their predecessors readily labeled ‘error’ and ‘superstition’. The more carefully they study, say, Aristotelian dynamics, phlogistic chemistry, or caloric thermodynamics, the more certain they feel that those once current views of nature were, as a whole, neither less scientific nor more the product of human idiosyncrasy than those current today. If these out-of-date

beliefs are to be called myths, then myths can be produced by the same sorts of methods and held for the same sorts of reasons that now lead to scientific knowledge. If, on the other hand, they are to be called science, then science has included bodies of belief quite incompatible with the ones we hold today. Given these alternatives, the historian must choose the latter. Out-of-date theories are not in principle unscientific because they have been discarded. That choice however, makes it difficult to see scientific development as a process of accretion. The same historical research that displays the difficulties in isolating the individual inventions and discoveries gives ground for profound doubts about the cumulative process through which these individual contributions to science were thought to have been compounded.”[8]

So we still have a ways to go to arrive at a generalized definition of science that allows us to proceed to determine if Indigenous cultures have indeed been doing and contributing to science and the parallels and contrasts with other paradigms purporting to be scientific. Samir Amin notes:

“Scientific theory is, after all, not theory that merely takes account of facts, but theory that proceeds from facts in order to integrate them into a coherent system”
[9]

That “coherent system” would have to include, as a key component, core principles and postulates of its own epistemology [10]; on what basis can we say we “know” something to be a fact before taking account of or proceeding from what we believe to be facts. That “coherent system” would have to include concrete approaches, criteria, methodologies, instruments, standards and tests for establishing the likely validity and reliability of facts, generalizations, theories, axioms and laws as well as criteria for selecting what to analyze in the first place. And that “coherent system” would have to have its own essential or foundational postulates and axioms about the essential nature of reality that must be accepted prior to any discussions about or approaches to understanding the essences of that reality. These foundational and guiding postulates may or may not be explicit but must be consistently applied. These “coherent systems” make up what Kuhn calls “paradigms” [11] and what others call schools of thought or “a science”. Since these paradigms include epistemologies, they should also contain postulates about the roles and limitations of human beings (biases, psychological filters, interests, constraints, physiology and contexts) involved in doing science and knowing as well.

Classical and Neoclassical Paradigms of “Science”

Neoclassical approaches in Economics that have been increasingly applied in other social sciences such as Anthropology, Ethnology, Sociology, History and Political Science draw heavily from the basic postulates about reality and knowing that originate from the classical-Greek-based and Newtonian notions of science and reality. For example, in Newton’s Three Laws of Motion and in the four Laws of Thermodynamics, we can see the focus on closed systems, clock-like mechanics, on reductionism (the notion that the task of science is to reduce all phenomena to their “essential” elements

and building blocks) but also other foci and postulates central to Classical and Neoclassical notions of “Science”[12]:

- 1) Focus on equilibrium states--static or dynamic--disturbed only by Exogenous (external) forces followed by endogenous processes creating new equilibriums;
- 2) Focus on ultimate Independent (Causal) and Dependent (Effect) variables in causality;
- 3) Focus on systems as morphostatic or endogenously self-correcting and self-equilibrating systems.;
- 4) Focus on unidirectional causality ($X \rightarrow Y \rightarrow Z$) and process;
- 5) Focus on negative (equilibrating) feedback effects.
- 6) Focus on closed systems;
- 7) Focus on a-priori sources and indirect proofs of knowledge;
- 8) The whole (macro) is merely the sum of its parts (micro) and the micro is a concentrated expression or microcosm of the whole;
- 9) Phenomena may be experimentally isolated and analyzed independent of the contexts and interactions with other variables with which they interact in reality;
- 10) Philosophical positivism: the only test of the validity hypotheses (including the validity of assumptions in hypotheses and deduction) is prediction (hypothetico deductivism);
- 11) As there is an objective reality independent of subjective biases and their causes, so there can be scientific methods and tools that are objective and value-free of any interests or biases on the part of scientists using them;
- 12) All hypotheses must be potentially falsifiable and all variables potentially measurable;
- 13) Aspects of reality may be analytically separated and studied in specialized disciplines;

Two Major Types of Cybernetic Systems

STABLE, EQUILIBRIATING SYSTEM

Morphostatic, structurally stable

E.G.: Thermostat-controlled mechanical system



System internally dynamic, but stable structure maintained and governed by *negative* feedback loops

UNSTABLE, DIS-EQUILIBRIUM SYSTEM

Morphogenetic, evolving new structure

E.G.: Living, biological systems, human societies



System internally dynamic and structurally dynamic governed by *positive* feedback loops, which amplify small changes into unpredictably large changes which can alter the whole system

(Source Henderson, Hazel, <http://www.hazelhenderson.com/visual.html>; reprinted under Fair Use Doctrine)

Classical approaches to science have yielded impressive discoveries that have made both positive and negative impacts on the planet and on humankind. As prediction and application are concrete tests of the “science” that went into yielding the particular predictions and applications, then discoveries of new drugs to extend human life, sending people 246,000 miles to land on a particular spot on the moon and return, and many other such achievements are testimonies to the power and methodological approaches embodied in what is known as “normal” of Classical and Neoclassical “science”. But then again, we could also chronicle some of the achievements, many unknown until recently, of Indigenous Science. The concept of Zero was first developed and used by the Mayans, many centuries before its recognition and application in the Near East and Europe. [13] The uses of natural medicines like Quinine for Malaria and Tubocurarine used today in abdominal surgery are but two of many examples.[14] There are achievements like Machu Picchu that represent advanced and integrated applications of principles of architecture, engineering, physics and cosmology that could not be duplicated by “modern” or “normal” science today.[15] In his trilogy, Jack Weatherford documents Indigenous pioneering achievements, “discovered” only centuries later by “normal science” in the areas of constitutions and governance, military tactics, agriculture and agronomy, cosmology, long distance navigation, architecture, engineering, medicine including even neurosurgery, unified monetary systems for long distance trade, preservatives for foods, mathematics and symbolic logic, flora and fauna management and breeding, effective education and pedagogy, law and constitutions, meteorology, immunology, and the list goes on.[16]

Theoretical physicist F. David Peat, who lived among the Blackfoot and studied

Blackfoot ceremonies like the Sun Dance as well as symbols, allegories and even language structure, found evidence of very advanced constructs of Quantum Mechanics, some “discovered” only in the early 20th century by “normal science”. These include: Superpositionality; Subtle Energy and Matter; Electrons; Wave-Particle duality; Entanglement; Bose-Einstein Condensates; Mass-Energy Equivalence; Heisenberg’s Uncertainty Principle; Fractals; The Four Laws of Thermodynamics; Grassmann Algebra. [17] From his studies of both Indigenous and what Kuhn called “normal” science, Peat concludes:

“During the first contact, Europeans were confident that they were the bearers of truth, truth about religion and government, truth about science and law. But today that confidence has been shaken. For some people, the truths of institutional religions are no longer self-evident, or even credible. And science, which has been through two great revolutions—quantum theory and relativity—is much less confident about the nature of objective truth.” [18]

More and more Classical science’s own concrete tests of validity of theory, prediction and application, are calling into question, the fundamental and defining postulates or asserted axioms, along with the often myopic reductionism, of Classical science itself. The most obvious example is global climate change about which there is not only disagreement by normal science and its scientists, as to its dimensions, dynamics, impacts and causes, but one may easily argue, that global climate change, which threatens the planet itself, is itself partly, or even largely, the product of the ultra-reductionism, ultra-specialization, myopia and non-holistic nature of what passes as “normal science”—especially when coupled and driven by the short-run, profit, competitive-survival imperatives of capitalism. Some argue that the paradigm of Classical science, that includes the notion that the whole is simply the sum of its parts, coupled with ultra-reductionism and ultra-specialization among various academic disciplines, leads easily to the “Fallacy of Composition” (“What is true in the particular must be true in general”) and the “Tragedy of the Commons” (individuals acting competitively and individualistically in what they think is rational self-interest in the short-run, destroying scarce and vital common resources necessary for collective as well as individual survival in the long-run) are being manifested and played out on national, regional and global scales with potentially disastrous consequences.[19]

In the social sciences, in attempts to gain legitimacy as “sciences”, there have been attempts to deal with some of the more glaring contradictions in neoclassical economics while preserving the essential postulates of the paradigm, and to extend Neoclassical constructs into other disciplines such as Sociology, History and even in Ethnology and Anthropology. Just like impersonal and “value-free” particles in perpetual motion in time-space, or the basic elements of all matter, of Physics and Chemistry, human beings are assumed to be “economic agents” or “Homo Oeconomicus” (Economic Man)[20] driven by bundles of propensities that are part of some immutable iron-laws and eternal “Human Nature”, to engage in predictable behaviors with ultimate causes or independent variables for all behavior (e.g. maximization of utility). The behaviors of these human particles (agents) in time-space, are asserted to arise irrespective of such

“fuzzy” and “immeasurable” (or not cardinally quantifiable) variables or factors such as historical context, type of socioeconomic system, personal histories, social class, race, ethnicity, religion, age, ideology, culture or any other real-world differences that are manifested among human beings. And since the social sciences are increasingly loaded with higher level mathematics to make them appear more scientific and rigorous[21], and since mathematics is assumed to be “value-free”, these disciplines increasingly argue that they only do “Positive” analysis (from Philosophical Positivism at the core of their epistemology: What is pure value-free cause and effect or how the world actually works) instead of “Normative” analysis (How the world “should” work).

What is interesting about many scientists of the Classical and Neoclassical persuasions is the lack of interest they appear to have on evolving research on the biological, chemical, psychological and physiological mechanisms and factors that cause human perception and other senses to be as shaped by what they think (paradigms) as what they think is shaped by what they see, hear, smell, touch and taste. In other words not only “seeing is believing”, but “believing is seeing.” Indeed the different paradigms that shape even what we choose to study, along with the sources and methods we use and consider legitimate, not only “explain the world differently, but also induce us to see a different world to explain.”[22]

These are issues dealing with limitations of the senses and roles of ideology in shaping perceptions and interests, not traditionally covered in epistemology, but certainly part of the problem of “knowing”, that are now being covered by some evolutionary biologists, cognitive psychologists and neurobiologists, that have long been incorporated into “Native Science” as well as more sophisticated versions of Dialectical-Historical Materialism. They have not been brought into the overall epistemologies of the Classical-Neoclassical or even Chaos-Complexity paradigms.

Indigenous Science

When speaking about what some call “Native Science” and what others call “Indigenous Science we faced several limitations. First of all, different Indigenous nations are exactly that: different nations with different histories, land bases, cultures, languages, socioeconomic structures etc that have some things in common but also some forms and levels of diversity as well. Secondly, the accounts we have are for the most part from those who study Indigenous societies but are not from or a part of the objects (cultures and paradigms) of their research.[23]

Is there some kind of evolving body or “coherent system”, of core principles and methods, tests of validity and reliability, procedures, axioms etc that would allow us to speak of Indigenous or Native “science” or a distinctive Native paradigm? We can list some of the core principles, axioms etc that form a coherent system that, as science is supposed to do, can be used not only to establish correlations and recurring patterns in aspects of reality, but also provide narratives and explanations as to why various predictable patterns and cycles occur with regularity in the cosmos on the one hand, versus highly conditional probabilities but not certainties on the quantum levels of

reality.[24] In Native science, the supposed contradiction between mere probabilities at the quantum or sub-atomic level of reality, as studied by Quantum Mechanics, versus regular, predictable and certain patterns and cycles of celestial bodies at the level of General Relativity Theory, is no contradiction. In all of what appears to be “chaos” of multiple-dimensions and probabilities but no certainties at the quantum level, there is often embodied the potential for order; and in all of what appears to be predictable, certain and recurring “order” at the macro level, there are contradictions and delicate webs of interdependency with the potential for chaos and implosion. In this respect and in others we shall discuss, Native science has more in common with Chaos Theory and Dialectical-Historical Materialism, which is not to say that Native science rejects all of Classical science.[25]

Some Principles and Approaches of Native Science

- The only constant is change (CT and DHM);
- Mathematics important but not foundational; mathematics not value free (CT and DHM);
- No ultimate independent (causal) or dependent (effect) variables (CT, DHM);
- All phenomena in process; thus phenomenon A can both be and yet not be (CT, DHM);
- All variables are endogenous (internal) depending upon scope/angle of analysis (CT, DHM);
- Reality is non-linear, causality is multidirectional and multi-faceted, development is not unidirectional from lower to higher orders; (CT and DHM);
- What Native People mean by “Spirit” is concentrated energy-matter, that is neither created nor destroyed but transformed from form to form and level to level in accordance with what amounts to the four Laws of Thermodynamics,[26];
- There is an objective reality outside of our consciousness but the relationships between ontology (existence) and epistemology (knowing) or between being and consciousness, are dialectical two-way as part of any reality involves the perceptions and interactions of those immersed in that reality. (CT, DHM);
- The notion that everything is interrelated, that there are no ultimate causes and effects of any phenomena, that all of the Cosmos involves extensive and delicate webs of interrelationships, actually aids rather than inhibits effective working models and narratives about how and why a particular phenomenon occurs, or why something works a certain way, or what will likely happen from given actions in Nature; (CT, DHM);
- The purpose of science is not to attempt to conquer, subdue or mitigate the forces and interrelationships of nature, but to understand them and work in accordance with them

to achieve survival and subsistence; (CT, DHM);

- Phenomena may appear self-equilibrating and Morphostatically stable, but they are in reality, continually in motion, subject to negative and positive feedback effects, driven by internal contradictions and interrelationships, to produce morphogenetic systems and outcomes that often represent qualitative leaps or volatile changes from relatively small quantitative changes over time.[27](CT,DHM);

- The context within which a given phenomenon being studied is never constant and can never realistically be treated as “a constant” or a “given” but it is an essential part of understanding what a given phenomenon within and part of—forming—that context is doing and why. (CT,DHM);

- The task of science is not simply to establish correlations between apparent or surface phenomena, or even to posit cause and effect, but to explain, with various kinds of narratives, why, with what periodicity, patterns and effects these interrelationships occur and in what directions are they changing; (DHM some CT);

- There is a dialectical unity between apparent Chaos and Order in that they are not only definitionally related, each defines the other, but are functionally related as in all apparent order is the potential for breakdown into chaos and in all apparent chaos there is underlying order to be discovered. (CT and DHM);

- Constructs and distinctions between time and space, animate and non-animate, individual and society, dreams and visions, perception and reality, causality and synchronicity, and time and eternity are our own constructs, imposed on reality because of, and manifesting, our own epistemological and other limitations more than the intrinsic nature of the reality.[28];

- The task of science is to discover both the implicate as well as explicate orders of reality [29];

- The task of science is not to dismiss from analysis anomalies that occur outside of or in contradiction to validating or nullifying predictions of hypotheses, but to explain them also without fear or favor to their implications on established interests (DHM)[30];

- Spirituality is not religion; it is being guided by the “spirit” (potential energy) of something beyond oneself and to understand the relationships of the phenomena of reality; part of scientific epistemology [31];

- All equations and models are symbolic representations or symbolic narratives (stories) about aspects of reality as much as story narratives; story narratives may be expressed in forms of equations—and vice versa--and may well capture more of the totality and essence of an aspect of reality than mathematical equations. (CT and DHM);

- True science must not merely be “interdisciplinary” but trans-disciplinary as reality is

an indivisible totality and not simply social, economic, physical chemical or whatever.(DHM)[32];

- “Nature “ is not simply a collection of objects, but rather a dynamic, ever-flowing river of creation inseparable from our own perceptions...the creative center from which we and everything else have come and to which we always return.”[33] (CT, DHM)
- “As we experience the world, so are we also experienced by the world.”[34](CT, DHM)
- In understanding phenomena, science can never effectively remain, or claim to remain, detached from that of which it is an integral part; total integrated immersion of the five senses plus cognition are required at all times; “controlled” experimentation, abstraction, simplification, instrumentation and the search for uniformity and “laws” are limited and said to be of limited value;
- Stories, trans-cultural symbols, allegories, metaphors serve as the same functions as theories, models and equations in normal science; languages are verb rather than noun-based emphasizing science as process rather than as a body or stock of tools and approaches; (CT, DHM)
- All of existence, including science, has purpose and the calling of science as with all activity, is to serve the community and its survival and sustainability. (DHM)
- The question of who is to benefit and who is to lose—for whom—is a central question for all science (CT, DHM)

These are but some of the core or foundational or defining ontological and epistemological principles of Indigenous science and how they parallel and/or contrast with Classical Science or what Kuhn calls “normal science” as well as with Chaos Theory and Dialectical-Historical Materialism as distinct paradigms. Of course in this exposition, some abstractions and simplifications have to be made for purposes of brevity and summarizing in a space-constrained exposition.

It would be a mistake to simply and summarily dismiss, as mere superstition, folkways, myths, and metaphysics what is increasingly being recognized as a whole and coherent system that qualifies as Native science and that has indeed produced some achievements that “modern” and “normal science” have no existing means or technologies to duplicate. In the symbols, rituals and ceremonies, structures like the Medicine Wheel, and numbers like the Sacred “Number Four”[35] one can find, and many Indigenous people understand, complex algorithms about the order of the Cosmos that guide everyday events and practices. Applying the tests of prediction and application favored by “normal science”, then Native science can make every claim to be science and perhaps more so than Classical science. How many pharmaceuticals in use today were first developed and used by Indigenous cultures and were then only considered to have been “discovered”, like the “discoveries” of Columbus, when obtained by Eurocentric forces and cultures? How do we explain the precision of the

Mayan Calendars if some kind of “science” was not going on? How do we explain the democratic institutions, agricultural practices, animal husbandry, cosmology, engineering of the likes of Macchu Pichu, and indeed warnings of the past that turned out to be very prophetic for the present and future that went unanswered and at our own peril [36]:

Letter from Chief Sealth to President Franklin Pierce--1855

" The Great Chief in Washington sends word that he wishes to buy our land. How can you buy or sell the sky--the warmth of the land. The idea is strange to us. Yet we do not own the freshness of the air or the sparkle of the water. How can you buy them from us. Every part of this earth is sacred to my people.

We know that the White Man does not understand our ways. One portion of the land is the same to him as the next, for he is a stranger who comes in the night and takes from the land whatever he needs. The earth is not his brother but his enemy, and when he has conquered it he moves on. He leaves his father's graves and his children's birthright is forgotten.

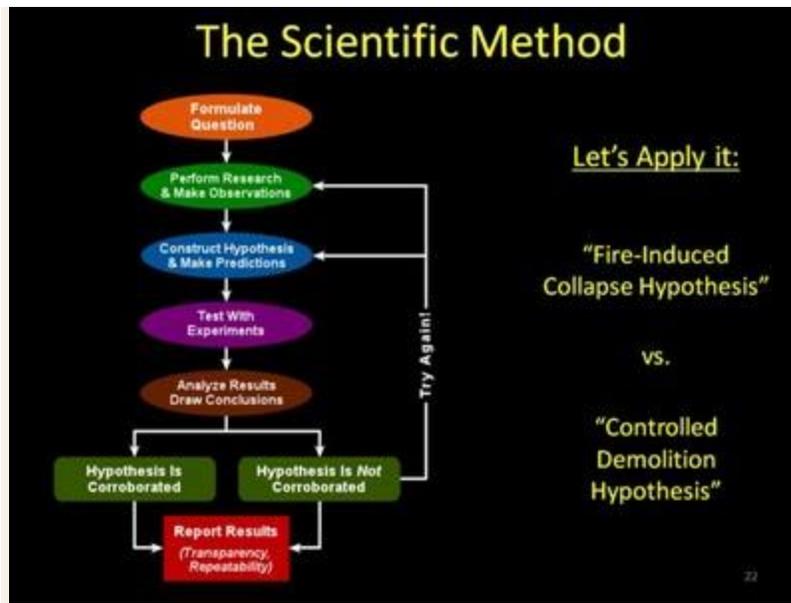
There is no quiet place in the White Man's cities. No place to hear the leaves of spring or the rustle of insect wings. But perhaps because I am savage and do not understand--the clatter only seems to insult the ears. And what is there to life if a man[sic] cannot hear the lonely cry of the whippoorwill or the arguments of a frog around the pond at night.

The Whites too, shall pass--perhaps sooner than other tribes. Continue to contaminate your bed and you will one night suffocate in your own waste. When the buffalo are all slaughtered, the wild horses tamed the secret corners of the forest heavy with the scent of many men, and the view of the ripe hills blotted by talking wires. Where is the thicket. Gone. Where is the eagle. Gone. And what is it to say goodbye to the swift and the hunt. The end of living and the beginning of survival. "

Chief Sealth 1855

Just as with losses of all sorts of flora and fauna species due to global climate change and other factors is causing losses of potential medicines for present and emerging diseases [37], so losses of whole Indigenous cultures represent losses for all of humanity of knowledge, values, practices and approaches to science that have produced and are producing many achievements that attest to their worth. It is not only flora and fauna diversity that will save this planet, preservation of cultural diversity is a survival imperative for the planet and humanity.

Where will the Classical Science take us? The answer is partly revealed in the products of the so-called “The’ [as if there were only one] “Scientific Method” (for good and bad) when coupled with the nature, logic and dynamics of various types of social systems that drive and utilize it.



(Architects and Engineers for Truth Slideshow)

Footnotes

[1] Cajete, Gregory; "Native Science: Natural Laws of Interdependence", Clear Light Publishers, Santa Fe, N.M. p.2

[2] Kuhn, Thomas S. "The Structure of Scientific Revolutions: Third Edition", University of Chicago Press, 1996

[3] Kuhn, Thomas Ibid. Kuhn wrote specifically on what he called "normal science" or a concept of science originating in Hellenic Greece and expressed in the foundations and traditions developed by Newton. Kuhn did not explore or even explicitly mention any non-Eurocentric notions or examples of science or scientific-like methods and approaches.

[4] "English, and for that matter French, German, Italian and the other European languages are noun-oriented. They are employed to divide the world into physical objects (nouns) and thinking into separate concepts (again nouns). Many Native American languages do not work this way. They are verb-based. Thus, when in English we speak of "medicine" we automatically seek a referent, a substance, an object, something tangible, and something that can be conceptualized. But suppose we begin with something verbal, with activity, process, a movement of harmony and balance. Medicine could then be felt in the beating of the heart, sensed as a movement around the sacred circle, the wind blowing through the leaves of the tress, the growing of green plants, and the astronomical alignments of the medicine wheel." Peat, F. David,

"Blackfoot Physics" Weiser Books, Boston, MA. 2005, p. 128

[5] Kuhn, Thomas S. op. cit. . p. 1

[6] A Tautology is a circular argument or definition. Examples include "Science is what scientists do and scientists are those who do science." Or, science is that which builds upon a foundation of what was generally regarded by a community of scientists as science."

[7] Kuhn, Thomas, op. cit, 1962 Edition, pp. 167-68

[8] Kuhn, Thomas S. op cit, Third Edition, pp. 2-3

[9] Amin, Samir, "Accumulation on a World Scale: A Critique of the Theory of Underdevelopment" Vol I, Monthly Review Press, N.Y. 1974 p. 2

[10] Epistemology means a Theory of Knowledge (also a coherent system) from the Greek "episteme" meaning knowledge or science and "logos" meaning theory of. A branch of philosophy dealing with the scope, limitations and tests of knowledge. What is knowledge? How is knowledge acquired? ; What do people know? How do we know what we know? Why do we know what we know? "Propositional knowledge" or knowledge that is distinguished from knowledge how. Knowledge involves belief but knowledge about a belief does not endorse the truth or accuracy of the belief. According to Aristotle:"To say of something which is that it is not, or to say of something which is not that it is, is false. However, to say of something which is that it is, or of something which is not that it is not, is true." Socrates, via Plato defined "knowledge" as "true belief that has been given an account of." Edmund Gettier proposed thought experiments (Gettier cases) to show that a given belief may be justified and true and yet not count as knowledge. Another doctrine is called "infallibilism" that says to qualify as knowledge, a belief must be not only true and justified, but that the justification for it must necessitate its truth. Another doctrine is that of "indefeasibility" employed in indirect proofs that says there must be no overriding or defeating truths against the reasons for the belief. "Reliabilism" is a doctrine that says a belief is justified only if it is established via a process that yields a sufficiently high ratio of true to false beliefs. Knowledge may be gained A-priori or outside of experience or A-posteriori via experience. Knowledge may be "analytic" or gained by knowledge of what terms mean in a proposition, or, may be "synthetic" or gained through propositions that have a distinct subject and predicate.

[11] "The dramatic changes of thinking that happened in physics at the beginning of this century have been widely discussed by physicists and philosophers for more than fifty years. They led Thomas Kuhn to the notion of a scientific "paradigm," defined as "a constellation of achievements—concepts, values, techniques, etc.— shared by a scientific community and used by that community to define legitimate problems and solutions." Changes of paradigms, according to Kuhn, occur in discontinuous, revolutionary breaks called "paradigm shifts." Capra, Fritjof. The Web of Life. New York: Bantam Doubleday Dell Publishing Group, 1996. P. 5

[12] Newton's Three Laws of Motion: Law I: "Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it."; Law II: " $F = ma$ " or Force equals mass times acceleration (acceleration and force are vectors and thus direction of the force vector is the same as the direction of the acceleration vector); Law III: "For every action there is an equal and opposite reaction" And the Four Laws of Thermodynamics: Zeroth Law: "If two thermodynamic systems are each in thermal equilibrium with a third, then they are in thermal equilibrium with each other"; First Law: "Energy can neither be created nor destroyed. It can only change forms."; Second Law: "Energy systems have a tendency to increase their entropy rather than decrease it."; Third Law: "As temperature approaches absolute zero, the entropy of a system approaches a constant minimum."

[13] Peat, F. David "Blackfoot Physics", Weiser Books, Boston, 2002 pp 191, 193-96, 216

[14] Restivo, Sal P. "Science Technology and Society: An Encyclopedia", Oxford U Press, N.Y. 2005 pp 213-16

[15] Wright, Kenneth and Alfredo Valencia, Machu Picchu: A Civil Engineering Marvel. ASCE Press, Reston. 2000

[16] Weatherford, Jack, "Native Roots: How the Indians Enriched America", Fawcett Columbine, N.Y. 1991;"Indian Givers: How the Indians of the Americas Transformed the World 1988; "Savages and Civilization: Who Will Survive?" 1994.

[17] Peat, F. David, op cit. pp 45-46, 130-34, 157, 170-71, 175, 261, 265-68

[18] Peat, F. David Ibid p. 45

[19] Garrett Hardin, "The Tragedy of the Commons", Science, Vol. 162, No. 3859 (December 13, 1968), pp. 1243-1248.

[20] "The concept of 'economic man' of the classical economists has long since been discarded as inadequate to reality—except by a few of the most ardent 'welfare theorists'. Meanwhile, the 'scientific man' is not even defined. He exists only implicitly in the form of a virtual taboo on raising the psychological and sociological problems of how research activity is conditioned." Myrdal, Gunnar, "Sociology and Psychology in Social Science" in "Against the Stream: Critical Essays on Economics" Pantheon Books, N.Y. 1973 p. 54

[21] The economist Robert Heilbroner once quipped that "mathematics has brought to economics rigor—and alas, also mortis."

[22] Wolff, Richard and Resnick, Stephen A, Economics: Marxian Versus Neoclassical, Johns Hopkins Press, Baltimore, 1987 p. 18. Other works on this subject include: Ariely,

Dan, "Predictably Irrational: The Hidden Forces That Shape Our Decisions", Expanded Edition, Harper Collins, 2009; Shermer, Michael "The Science of Good and Evil: Why People Cheat, Gossip, Care, Share and Follow the Golden Rule" Holt, N.Y. 2004 and "The Mind of the Market: How Biology and Psychology Shape Our Economic Lives", Holt, N.Y. 2008; Deutsch, David, "The Fabric of Reality" Penguin, N.Y. 1997; Deloria, Vine, "Spirit and Reason", Fulcrum Publishing, Golden, CO 1999; Myrdal, Gunnar, "Against the Stream" op cit; Westen, Drew, "The Political Brain: The Role of Emotion in Deciding the Fate of the Nation", Public Affairs, N.Y. 2008; Gardner, Daniel "The Science of Fear: How the Culture of Fear Manipulates Your Brain", Plume Books, N.Y. 2008

[23] Cajete, Gregory, op cit. p. 4 "As is true of all lenses, what we can see depends upon the clarity of the images made possible through the use of a particular lens. In the past five hundred years of contact with Western culture, Native traditions have been viewed and expressed largely through the lens of Western thought, language and perception. The Western lens reflects all other cultural traditions through the filters of the modern view of the world. Yet in order to understand Native cultures one must be able to see through their lenses and hear their stories in their voice through their experience. In other words to know the taste of a pear one must bite into it.

[24] Peat, F. David, op cit p 157: "The ability to place an opening so that it will be aligned with the rising sun at the solstice or equinox, or with some other event, clearly implies the ability to predict and calculate the location of these events in the sky. Indeed, the design of a building represents a perfect integration of mathematics, astronomy, surveying and architecture."

[25] Cajete, Gregory, op cit. p.2: "Native science is a metaphor for a wide range of tribal processes of perceiving, thinking, acting and 'coming to know' that have evolved through human experience with the natural world. Native science is born of a lived and storied participation with the natural landscape. To gain a sense of Native science one must 'participate' with the natural world, to understand the foundations of Native science one must become open to the roles of sensation, perception, imagination, emotion, symbols, and spirit as well as that of concept, logic and rational empiricism."

[26] Little Bear, Leroy Into to Cajete, Gregory op. cit p. p. x; Deloria, Vine, "Spirit and Reason", Fulcrum Books, Golden, Co 1999; Peat, F. David, op. cit

[27] Symbolized by the famous "Trickster" in many Native stories of various nations. In Peat, David F. op cit: "The sacred figures of the People—Raven, Coyote, Napi, Nanabush and the rest—are all tricksters, beings who turn the world on its head. Even our own Western science has its trickster: entropy or disorder. ..In scientist's terms the overall entropy of a system and its environment must increase or, to put it another way, if we insist upon generating order, this can only be done at the expense of creating disorder somewhere else." P. 83

[28] Peat, David F. Ibid p. 4

[29] According to physicist David Bohm, the “implicate” or enfolded order is a deeper order in which the whole of a phenomenon is enfolded or embodied in each part. (like the commodity was a concentrated expression or microcosm or the macrocosm of capitalism was for Karl Marx) while the explicate order is the surface immediately perceived by our senses. Bohm, David, “Wholeness and the Implicate Order”, Routledge and Kegan Paul, Boston, 1981

[30] Kuhn, Thomas S. op cit. p. 6 “...normal science repeatedly goes astray...when it does—when, that is, the [scientific] profession can no longer evade anomalies that subvert the tradition of existing scientific practice...

[31] Deloria, Vine, “Spirit and Reason” op cit. p. xiii

[32] Amin, Samir, op cit p. 5

[33] Cajete, Gregory, op cit pp 15-16

[34] Cajete, Gregory, Ibid. p.20

[35] In Blackfoot culture, as in most Indigenous cultures, the number four is not merely a quantity or cardinal magnitude, without quality or force as in many Eurocentric cultures (four of what?); it has its own power, symbolism and force giving it quality in addition to quantity. The number four stands for: the four principle directions of the compass (North, South, East and West); the four principle colors of the human family (Black White Red and Yellow); the four forms of balance that all humans must seek to survive and prosper (Physical, Emotional, Mental and Spiritual); the four basic elements of Nature (Wind, Fire, Earth and Water). In this model, there are four basic dimensions of development and sustainability that illustrate the dialectical unity of the macro and the micro levels of existence: control of assets and kinship (macro) and personal efficacy and spirituality (micro).

[36] This was based on a translation of a speech by Chief Sealth from Suquamish into Chinook jargon and then into English. It’s authenticity has been questioned only on the basis that Chief Sealth sounded too articulate to be the real author and that it must have been written by a screenwriter.

[37] Scientists estimate there are 10 to 30 million plant and animal species on the planet, most of them unidentified. Each year as many as 50,000 species disappear; Olson, Dan “Species Extinction Rate Speeding Up”, Minnesota Public Radio, Feb. 1, 2005
http://news.minnesota.publicradio.org/features/2005/01/31_olsond_biodiversity/