"Ethics and the Thermodynamic Imperative."

by

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Although parts of the religious teachings from the Hebrew-Christian tradition of Western Civilization require modification as science advances, the more fundamental rules of ethics remain valid. With the need for cooperation between the countries of Western Civilization other cultures it becomes important to recognize the common ethical concepts underlying all the different religious traditions. Perhaps Albert Schweitzer has laid the base for global cooperation in his principle of "Reverence for Life."

A formulation of "maximizing the negative entropy" from Information Theory (or Cybernetics) could possibly put Dr. Schweitzer's "Reverence for Life" on a more universal basis so that scientists in the U.S.S.R., who might be hostile to organized religion could understand the ethics distilled from the major historical religions. A scientific base might also appeal to Chinese scientists.

To establish a closer contact with Christian philosophy, it is useful to go back to Immanuel Kant (1724-1804) and his "categorical imperative" in his "Transition from Popular Moral Philosophy to the Metaphysic of Morals."

> "There is therefore but one categorical imperative, namely, this: Act only on that maxim whereby thou canst at the same time will that it should become a universal law." *

Accordingly the practical imperative will be as follows:

> "So act as to treat humanity, whether in thine own person or in that of any other, in every case as an end withal, never as a means only" #

*Immanuel Kant, Britannica Great Books, vol. 42, p. 268.
Ibid., p. 272.

R. B. Lindsay* points out that certain hypothetical ethical precepts can be set up, as for example, the Golden Rule, Kant's categorical imperative, or the more specific commandments of the Decalogue.(p. 413)

* Bernard Baumrin, editor, Philosophy of Science - The Delaware Seminar, vol. 2, (1962-1063). N.Y: Interscience Publishers(1963) pp. 411-448. "Physics, Ethics and the Thermodynamic Imperative."

He asks "Where do the imperativess or commands of an ethical theory come from?" ....."It may seem somewhat surprising that we shall turn to thermodynamics in our search for an ethical imperative..... .....energy.....entropy...." (p. 428)

Life then may fairly be said to consume entropy, since with the transition from disorder to order, the entropy of the universe decreases. ..... entropy consumption and reproduction..... .....thermodynamic imperative:

> "All men should fight always as vigorously as possible to increase the degree of order in their environment, i.e., consume as much entropy as possible, in order to combat the natural tendency for entropy to increase and for order in the universe to be transformed into disorder, in accordance with the second law of thermodynamics" (p. 440)

It is interesting to note that R. B. Lindsay's formulation of the "thermodynamic imperative" is a more fundamental form of the principle of "maximizing the negative entropy" which I have developed in my Cleveland 1963 paper and in my London 1964 paper. What my papers do is to bring some engineering models to use to develop measures of how mankind is doing in following the "thermodynami imperative."

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There is a parallel development of thought reported by R. B. Lindsay in his book, The Role of Science in Civilization (Harper & Row, 1963), which has a chapter on Information Theory and concepts from Thermodynamics. Dr. Lindsay asks, can there be a science of ethics? He reviews the Golden Rule, the Ten Commandments, Immanuel Kant's Categorical Imperative and then develops a "thermodynamic imperative":

> "All men should fight always as vigorously as possible to increase the degree of order in their environment, i.e., consume as much entropy as possible, in order to combat the natural tendency for entropy to increase and for order in the universe to be transformed into disorder, in accordance with the second law of thermodynamics. (p. 212.)

The above thermodynamic imperative is illustrative of the kind of ethical concept that can be derived by analogy from the science and mathematics at the base of our technological society. However I feel that Professor Lindsay, in translating the word entropy into order for the layman, has lost part of the meaning. When one uses a communication theory model to impliment Lindsay's thermodynamic imperative, it becomes apparent that "increase the degree of order" should be replaced by "optimize the order-diversity balance", and that after disorder in the second from the last line, one should insert "and diversity to be transformed into conformity," Thus the use of an electrical communication theory model makes the thermodynamic imperative a more useful hypothesis.

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Threats to Human Values

In our efforts to make our sociological system more efficient, we concentrate our attention on variables that can be expressed by numbers that can be fed into our computers. John Wilkinson, of the Center for the Study of Democratic Institutions, has expressed a concern that our quantitative society is pushing values out of the picture.[48]

At a seminar on manpower policy andprograms in Washington, D. C. in April 1964, Dr. Donald N. Michael said:

> One problem that is very central here is the tendency for planners and decisions makers to come to overvalue that which the computer can deal with; that is, to place most emphasis on those aspectsof the world which the computer can handle - usually the statistical - and in turn, to ignore the ineffable, the points off the curve, the unique person. Then all these individualistic attributes are dealt with by the inclusion of a ritualistic addendum which stresses the integrity and individuality of people! It will be very difficult to find a felicitous balance between the positive contributions the computer must make to society's development and the damage it can do to our respect for the individual. And this stress on the statistical will be a growing threat to our values about the sacredness of the individual. I think it is inevitable. There is a crisis ahead of us for the conventional and traditional democratic process.[49]

If we examine our perspective of cybernetic models and ecologies, we will find at the intersection of large systems, fine structure, and coarse quantizations that there is a sociological model based upon analogous transmission line from electrical communication theory that can help us keep values in the system.[50]

Now I make the hypothesis that examination of this analogy can be much more than the type of "ritualistic addendum" mentioned by Dr. Michael. The concept "entropy" from physics which is briefly mentioned by Wilkinson, when examined from the viewpoint of General System Theory, can give us a valuable tool with which to help maintain respect for individual human values in a mass society.

The possibility that entropy from thermodynamics might belong both to the family of measurable quantities of science and the family of values such as beauty and melody was suggested in 1928 by Eddington.[51]

Consider the categories in Table 2. Can you group these into two classes of related categories? The first three are obviously related by their common property of being physically measurable quantities. Numbers 5 and 6 cannot be weighed or measured with a yardstick. There is something about beauty and melody which is not reduced to measurable units; these categories involve emotional feelings which are both more complex and more elementary in human development. Does entropy belong in Class I or II? Entropy is a measure of the ratio of disorder to order, a measure of something similar to beauty and melody, so it belongs in Class II. Yet at the same time,

Table 2: Classification of Categories

CATEGORY	CLASS I Measureable	CLASS II Non-Measureable
1) Distance	X	
2) Mass	X	
3) Electric Force	X	
4) Entropy	?	?
5) Beauty		X
6) Melody		X

entropy in thermodynamics (the relationship between heat and energy) is a measurable quantity defined by equations. Thus the concept of entropy becomes a link between the scientifically measurable and the emotionally meaningful.

At about the same time as Eddington's suggestion, Leo Szilard was thinking about the quantitative relationship between the entropy lost by a gas and information gained by a hypothetical "Maxwell's demon," opening and shutting the door between two compartments to separate the high and low-energy particles of a gas.[52] Dr. Szilard's paper was relatively unnoticed until the development of the mathematical theory of communication by Shannon in 1948,[53] which became known as Information Theory, and [the] [partically] overlapping concepts of Cybernetics developed by Norbert Wiener.[54]

Biological systems preserve or increase order, decreasing entropy in a limited domain, even though over a larger domain entropy is increased in accordance with the Second Law of Thermodynamics. The units of information are related to both the life process and to negative entropy in thermodynamics, as has been discussed by both Schrodinger, Brillouin, and Lindsay.[55]

Physically entropy can be defined as:

$$S = k \ln P, \qquad [1]$$

where k is the Boltzman constant, "ln" means logarithm of, and P is the number of elementary states in which the system can be.

Negentropy in Information Theory, a branch of electrical engineering and mathematics, in respect to a set of n messages is:

$H = -(P_1 \ln P_1 + P_2 \ln P_2 \ldots\ldots + P_k \ln P_k + \ldots + P_n \ln P_n)$ [2]

where P_k is the probability of occurence of message K. This gives us a measure of the efficiency of a set of telegraph messages. For a basic discussion of these concepts see Colin Cherry, On Human Communication, or J.R. Pierce, Symbols, Signals and Noise.[56]

If we take the formula for information or negentropy of a set of telegraph messages or computer instructions and substitute a set of n philosophical systems (or political systems) in place of the n messages or instructions, the probabilities of occurrence of the respective philosophies among the population of a country assumes a role analogous to the probabilities of occurrence of the n messages.

If one philosophy is required as the official philosophy by order of a dictator and the philosophy is number "k", then:

$H = -(0x1 + 0x1 \ldots\ldots + 1x0 + \ldots + 0x1) = 0.$ [3]

Thus the requirement that people adhere to an official philosophy is equivalent to a zero contribution to the negative entropy of the political system or the "life process" of the evolution toward a higher order of life. If we go back to equation 2 to see under what conditions there is a maximum contribution to the negentropy of "life process," we find when all P_i's are equal such that $P_i = 1/n$ is the condition for maximum H. Under these conditions $H = \ln n$. This corresponds to equal probability for each different philosophy, a condition approximating a democracy, provided that n is not so high that no decisions can be made by the country.

What does this use of the telegraph cable analogy mean? It reminds us that we have only included data for which we can find numbers to put into our input-output tables.

By our analogy with the negentropy of a set of telegraph messages, we are reminded to consider the potential of each human being or small group of humans. An individual or small group may have some important message for mankind, but it may be in the form of poetry or music which does not fit our data format for economic models.