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# Entropy and Society: Can the Physical/Mathematical Notions of Entropy Be Usefully Imported into the Social Sphere?

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## Synopsis

The notion of entropy was first introduced in the 1850's by Rudolf Clausius in the context of thermodynamics. Focusing on the meaning that an increase of entropy means an increase of disorder, dissipation and decay, subsequent generations of authors have imported the notion into practically every area of intellectual discussion.

This paper will mention numerous definitions of entropy and consider the virtues and ambiguities of the concept of entropy. It will pass judgement on some old and new interpretations of certain current societal developments that have been made along entropic lines and that conflict with the current Western social ethos.

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*Two dangers constantly threaten the world: order and disorder.*

–Paul Valéry

## Foreword: A Personal Reminiscence

At the 1950 International Congress of Mathematics, held in Cambridge, Massachusetts, there was an public discussion held by Norbert Wiener and Nicolas Rashevsky. The name of Wiener remains well known today, but the name of mathematical biologist Rashevsky, a maverick at the University of Chicago has faded somewhat. At the time, I was a brand new Ph.D. in mathematics, and sat in the audience with friends. I recall little of the

discussion that went back and forth – only this: that Wiener said something like “*Entropy is the logarithm of a probability. Of the two: entropy and energy, entropy is the important thing.*”

## 1. Introduction

At the time of the Congress, Wiener had been working on his book *The Human Use of Human Beings* [14]. In the 1954 edition he wrote:

“As entropy increases, the universe, and all closed systems in the universe, tend naturally to deteriorate and lose their distinctiveness, to move from the least to the most probable state, from a state of organization and differentiation in which distinctions and forms exist, to a state of chaos and sameness. In [Josiah Willard] Gibbs’ universe order is least probable, chaos most probable. But while the universe as a whole, tends to run down, there are local enclaves of whose direction seems opposed to that of the universe at large and in which there is a limited and temporary tendency for organization to increase. Life finds its home in these enclaves. It is with this point of view at its core that the new science of Cybernetics began its development.”

Wiener’s enormous scientific reputation combined with the popularity of his book have served to fix the notion that an increase in entropy is a deeply dire event. A half century later, energy, not entropy, is on everybody’s tongue; how and where to get energy and how to save it, what it costs, what its geo-political implications are. Discussions of entropy, on the contrary, are carried out mainly by theoreticians and by glum cosmic pessimistic writers. Though neglected by the daily newspapers, entropy refuses to go away. Global warming, Nobelist Al Gore’s “Inconvenient Truth,” is but an instance of the increase of entropy, and invoking this term should suggest numerous other inconvenient truths, largely ignored by the public. Yet, a recent popular book on physics [8] contains a great deal about energy but not a word about entropy.

If not on everybody’s tongue, (indeed, a junior high student recently told me she was familiar with the word “entropy” from her classes, but did not recall what it meant) the word has diffused – some have said it has spread like a virus – into the common language and into many intellectual circles. Dozens of different definitions (or at least different slants) and conclusions

exist. Authors employing the term range widely from apocalypticists to mathematicians, physicists and physicians, to information theorists, to musicians and film makers, to art and literary critics, to social anthropologists, to theologians all of whom, in their descriptions, speculations, fantasies and predictions have given us insights as well as spawning inconsistencies, misunderstandings, controversies, confusions, paradoxes and dilemmas.

It is worth considering the reasons for this spread. Part of the reason is that it is chic or clever to be on the “cutting edge of ideas” by using scientific terminology – a form of name-dropping; but much more significantly, entropy provides a wide descriptive framework, often metaphorical, into which one can fit or unify diverse observable phenomena. Some authors, as though they had patent rights to the word, have complained that other authors have “kidnapped” the word, forcing it to serve devious and unjustifiable purposes; but a word, once coined, is lexicographically in the public domain, and its meanings fan out and cannot be pinned down or confined. Thus, for example, the word “salvation” carries as many different meanings as there are religious or secular groups that deem to use it.

Entropy has been characterized variously and vaguely by the words decadence, decay, anarchy, distopia, randomness, chaos, waste, inefficiency, dissipation, loss of available energy, irreversibility, indeterminacy, most probable states, equilibrium, thermal death, the cause of or the accompanier of the uni-directional arrow of time. In the social sphere it has been characterized as apocalypse, disorder, disorganization, disappearance of distinctions, meaninglessness, absurdity, uncertainty, pandemonium, loss of information, inert uniformity, incoherence. The situation is complex because most of these words carry multiple meanings. The word “chaos” is notorious in this regard.

Moreover, as implied, writers often use the term in their own private, Humpty Dumpty sense.<sup>1</sup> Considering the various usages of the word “entropy” all the way from the scientific to the popular, I find it to be such a muddle of ideas that it makes the “wet sponge” sentences of President Warren G. Harding sound like crystal clear thought. Yet, hovering over all these interpretations – like a ghost in the closet – is the spirit of the famous and notorious 2<sup>nd</sup> Law of Thermodynamics, which states that although the energy in a closed universe is constant (1<sup>st</sup> Law), the energy available to do

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<sup>1</sup>“When I use a word, Humpty Dumpty said, in a rather scornful tone, it means just what I choose it to mean, neither more nor less.”

useful work becomes less and less. (A full description and discussion of these laws would require a large book.) Charles Sanders Peirce said that the 2<sup>nd</sup> Law was the finest intellectual achievement of the 19<sup>th</sup> Century while a more recent Charles – C.P.Snow – opined that every humanist ought to be familiar with the 2<sup>nd</sup> Law.

While an increase in entropy is in some views considered “bad” or “pessimistic,” or “depressing,” in other senses it appears absolutely necessary to make the world function as it appears to be functioning. As one physicist wrote me: “Despite all appearances, if properly defined, entropy is always and everywhere increasing.” Yet, there are, as Wiener pointed out in his statement, “local enclaves” in which entropy is reduced. This is considered the “good” direction for the movement of entropy, and within such enclaves we can locate first and foremost, life itself; its origin and its evolution into myriads of forms. There is also the application of intelligence, and self-organization in a variety of fields. Recall, though, that “good and bad” are subjective adjectives that relate to the realities of life as we experience them in our particular milieu in our particular time frame.

“Local enclaves”? Yes, but as suggested, a physicist might state firmly that all local decreases are matched elsewhere by increases so that the juggernaut march of entropy increase goes on, as does time itself, making entropy simply a reparameterization of time or vice versa. Thus, paradoxically, entropy, which starts out life as a probability, ends up as an iron-clad deterministic element in a probabilistic universe.

## 2. Definitions of Entropy

What, then, is this polysemic concept known as entropy? Disorder? Certainly – or mostly – but what, then, does order mean? A regularity, an arrangement, a systematization? A classification according to some definition? What are these? Is order an objective or a subjective concept? Is it culture dependent? My order can often be your disorder. If library books are ordered alphabetically by author, they may appear disordered by subject. Yet, if the concept of order is objective, can we assign a numerical quantity to it so that “more” or “less” become meaningful?

With respect to entropy, we seem, in point of fact, to be in a position that is the *exact reverse* of St. Augustine’s famous quip

“What is time? If no one asks me, I know what it is. If I wish to explain it, I do not know.”

In contrast, many writers seem to be personally acquainted with entropy and they are more than willing to invent new definitions and even to employ the term in the absence of strict definitions, hoping that the examples they present will imply a definition of what they are talking about.

Around 1848, George Corliss of Providence, RI, was inventing steam engines of increasing efficiency (the Corliss Engine). On the theoretical side, around the same time, Rudolf Clausius in 1854-1865 considered efficiency from the point of view of thermodynamics, a field of which he was a founding father, and he created the notion of entropy. Clausius produced an equation for the entropy of a system as follows

$$\Delta S = Q/T$$

where  $\Delta S$  designates the change in entropy,  $Q$  the amount of heat added to a the system and  $T$  is the temperature. For a closed thermodynamic system, entropy is a quantitative measure of the amount of degraded thermal energy not available to do work. Energy available to do useful work has been termed “free energy” by Josiah Willard Gibbs. It is a principle of thermodynamics that the entropy of the universe always increases. As a consequence, one may be led to conclude the famous “heat death” as the ultimate fate of the universe.

As a less teleological and dramatic example, when you saw a piece of wood, the free energy in your body heats up the saw and the wood. The heat so generated is less capable of being productive.

There is entropy from statistical mechanics (Boltzmann). Take a cup of white seeds and a cup of black seeds. Put them in a bowl and mix them thoroughly. Further mixing will never separate the seeds into groups of black and white. Mixing has converted organization into disorganization, increasing the entropy.

There is entropy in information theory – a rather different theory – and is associated with the name of Claude Shannon. Restricting our attention to the space of probabilistic sequences  $[p_1, p_2, \dots, p_n, \dots]$ , leads to the formula

$$\sum p_k \log p_k.$$

But numerous other definitions have been suggested. For example, the Rényi entropy is defined as:

$$(1/(1 - \alpha)) \log \sum p_k^\alpha,$$

while von Neumann (quantum) entropy is given by the formula

$$- \sum \lambda_k \log \lambda_k.$$

In the latter the  $\lambda_k$  are the eigenvalues of a certain “quantum density matrix”  $D$ . There is more; we can also talk about matter entropy<sup>2</sup>, Kolmogorov-Sinai entropy in dynamical systems, topological entropy, black hole entropy, genetic and natural selection entropies, and even these do not end the list.

A somewhat different set of examples comes from the world of literary usages and composition. Thus, there have been studies relating entropy with Zipf’s Law describing the relation between individual word rankings and word probabilities. The comprehensibility of literary texts may also be associated with low entropy. Measuring it is the goal of the Flesch-Kincaid Reading Ease Score (FRES) test, available online. (A large variety of such indices have been constructed.) FRES is an entropy-like measure, and is based on three parameters:  $a$  = total number of words,  $b$  = total number of sentences, and  $c$  = total number of syllables. With this notation, FRES can then be computed as:

$$FRES = 206.835 - 1.015(a/b) - 84.6(c/a).$$

With this formula, a high score indicates a high degree of ease of readability and hence low entropy. The Flesch-Kincaid index also produces the school level at which a given text should be comprehensible. The FRES applied to the long quotation of Norbert Wiener at the beginning of this article gave Grade 16.

Within the humanistic areas, there have been alluded to or defined implicitly psychological, social, civic, economic, corporate, literary, personal<sup>3</sup>, even military entropies. In these areas, the concept is used more or less as a metaphor or a synonym for chaos, disorder, breakdowns, dysfunctions, waste of material and energy, enervation, friction, inefficiencies. (For example, military entropy is the tendency of military operations initially to create destruction and disorder.) The concept generates insights that are often contradictory and the consequences of which often tease common sense

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<sup>2</sup>Since matter does not disappear during a transformation process, a certain amount of it becomes unuseful to us.

<sup>3</sup>One proposed measure of “personal entropy” (PE) is based on miles driven per year, miles per gallon, total monthly utility bills, time spent on the Internet, etc.

and offend morality. Nonetheless, the concept has proved to be both widely generalizable and intriguing, with theoreticians of all stripes riding off with it madly in all directions, leaving steam engines and information theory far behind.

### 3. Human Time and Cosmic Time

Recall Wiener's "local enclaves" in which entropy may decrease. I interpret such enclaves as regions limited in both space and time. With linear scientific time scales varying from  $10^{-35}$  seconds to  $10^{35}$  years, with individual or characteristic "human cultures" often estimated at  $10^4$  years, with individual human life spans approaching  $10^2$  years, each of these spans carries its own entropic events. There is a tendency (perhaps metaphoric and existing principally in science fiction) to project the concerns of one time frame onto another and from one galaxy onto another. We are entertained by such fiction, but I do not believe that writers on the fate of the universe worry about its deterioration (in Wiener's sense) within their lifetimes. Considering the transitions from one age to another, from, say, the bronze to the iron age or from feudalism to capitalism, historians of entropy have not considered deeply how these transitions are accompanied by different entropic characteristics. Overriding all is the quip of John Maynard Keynes that "in the long run, we are all dead," and while this is equally true of the fruit fly or of Galaxy GGX-9, it transcends the glories and the agonies found within the local enclaves.

### 4. "Good" Increases in Entropy

Local increases or decreases in entropy have been perceived as "good," "bad" or "indifferent." These are subjective judgments often based on perceived utility. Here are a few examples of good increases in entropy. A baker assembles flour, yeast, water, salt, perhaps a few more ingredients depending on the recipe. The baker then distributes these ingredients uniformly into a mass by the process of kneading. The uniformization increases the entropy and provides us with bread: the "staff of life." Ditto for scrambled eggs and many other mixtures, alimentary or otherwise.

Consider the social phenomenon of the "Melting Pot." This term was popularized in 1908 by Israel Zangwill of England in both a novel and a play which was highly regarded by Theodore Roosevelt, then President of



the USA. When diverse groups of population “melt,” this implies an increase in entropy; but such melting is currently a source of great contention with some desiring it and others fearful of it.

The admittedly contentious “principle of maximum entropy” or the “principle of insufficient reason” or of “indifference” (J. M. Keynes) is often a recommended procedural strategy. This goes back easily to Jakob Bernoulli. Suppose that a complicated situation is characterized by a variety of possible outcomes with unknown probabilities  $P : (p_1, p_2, \dots, p_n)$ , their sum equaling 1. The Shannon measure of the entropy of  $P$ ,  $Q(P)$ , is given by

$$Q(P) = - \sum p_k \log p_k.$$

This measure of entropy,  $Q(P)$ , is demonstrably maximized by selecting  $P$  as the uniform distribution  $P = (1, 1, 1, \dots, 1)/n$ . When there is no knowledge indicating unequal probabilities, the attribution of equal probabilities is recommended. E.T. Jaynes and numerous others have elaborated and justified this procedure. The principle has often been considered simply as an exercise of “common sense.”

Aestheticians have opined that ideally art must contain both the ordered and the disordered. Symmetry is one of the great and pervading principles of order. What is totally ordered can be perceived as static and boring and in the social area has been identified with fascism and repression. Thus symmetries must be broken. Yet what is totally disordered is incomprehensible.

A colleague with a cluttered office said to me “I can live with it.” For an amusing and enlightening discussion of the benefits of disorder in one’s daily personal life, I recommend Abrahamson & Freedman’s *A Perfect Mess* [1].

## 5. Entropic Paradoxes and Ambiguities

Here is art theorist and psychologist Rudolf Arnheim in *Entropy and Art*:

“The less likely an event is to happen, the more information does its occurrence represent, This seems reasonable. Now what sort of sequence of events will be least predictable and therefore carry a maximum of information? Obviously a totally disordered one, since when we are confronted with chaos we can never predict what will happen next. The conclusion is that total disorder provides a maximum of information; and since information is measured by order, the maximum of order is conveyed by a maximum of disorder.” [4, p.15]

Our supermarket announces that it stocks 35,000 different kinds of items. When I was a child, I doubt if a grocery store had 1,000 different items and this was considered quite adequate. Does the current proliferation of product varieties represent a decrease in entropy or is it a chaotic situation, wasting time and energy? Some recent well-publicized psychological studies showed that people make worse decisions when presented with too many options. A probabilist might say that the answer can be found by first obtaining the probability  $p_i$  of buying the  $i$ th item, and then the entropy can be computed by using Shannon's formula.

## 6. Abstraction and Entropy

There is a principle of progress or of movement in mathematics (and in other disciplines) towards increasing abstraction. An often-cited observation of E. H. Moore (1906) describes the process this way:

“The existence of analogies between central features of various theories implies the existence of a general abstract theory which underlies the particular theories and unifies them with respect to those central features.”

If in such a unification the details of individual theories are then downplayed in favor of the abstraction, does this, then, represent an increase in entropy? If one speaks of humankind, downplaying John Doe and Mary Roe, is this an increase in entropy?

Oswald Spengler decried the abstraction of number as well as the assertion of the unity of mathematics:

“There is not and cannot be number as such. There are several number worlds as there are several Cultures. We find an Indian, an Arabian, a Classical, a Western type of mathematical thought and, corresponding with each, a type of number – each type fundamentally peculiar and unique, an expression of a specific world feeling, a symbol having specific validity which is even capable of having scientific definition, a principle of ordering the Become, which reflects the central essence of one and only one soul, viz., the soul of that particular Culture... Consequently there are more mathematics than one.”

Let me elaborate the question of abstraction just a bit. Consider the number 5. The same number can be written in Arabic letters as 5, in Roman letters as V, or in Hebrew letters as ה. It can be spoken as “five,” “fünf,” “pet,” etc., and spoken with different accents. It can be displayed as



It recalls to mind many connections such as  $5 + 5 = 10$ ;  $5^5 = 3125$ ; there are the five Great Lakes. Five is the number of vertices of a pentagon; five is one half the number of the British Prime Minister’s official residence. It may remind one of Abraham Lincoln on a Five Dollar Bill. It is one element in the set of integers often designated by mathematicians as  $\mathbb{Z}$ . It is the Pythagorean symbol of man and the number of fingers on a hand. A dematerialized five may reside, somehow as a material trace in a person’s brain or in a computer memory.

The number 5, therefore, comes surrounded by a vast cloud containing an very large number of facts, associations, geometric images, sounds, feelings, symbols, metaphors, etc. Such a cloud varies from person to person and from time to time. Now in the process of mathematical abstraction, the number 5 is stripped of all the clouds that surround it, and stands naked, as it were, as a pure platonic conception existing in all time, in all possible universes and is independent of people who have engaged with it in some manner. A Platonist would assert further that this stripped five is available and comprehensible in an identical way to all peoples, all times, all possible universes.

Thus, the process of abstraction implies a loss of information and hence is a degradation. Can we say, therefore, that the process of abstraction is entropy increasing? Does the physicist’s search for unified theories or even a “theory of everything” imply a loss of information or of ordering and hence an increase in entropy? Or is it simply a case of poor semantics?

## **7. Entropy and Society**

In our personal and daily life some of us have noted the tendency for our desks and even our houses to become more and more cluttered. Perhaps entropy is at least a useful metaphor in that situation and is one that can be extended. In our personal lives, also, the rapid changes we have experienced have caused in us feelings of dislocation, regret, and the certainty of cultural deterioration. But the idea that the world is “going to hell in a bucket” is

an old one and there was no need to wait for Clausius and his scientific followers to have based this conclusion on mathematical formulas. In classic Greek literature one finds statements that the “great days” were in the past. Theological eschatologies abound in which the “final days” were yearned for and thought of as welcome relief for the ills/sins/horrors of the world. Giambattista Vico (1668-1744) described the movement of civilization as from a poetic and imaginative past, to a flat, passionless present. But with the advent of thermodynamic entropy, historical pessimism and despair found a strong conceptual ally, a template onto which to hitch historiographical speculations and – by no means least – to acquire the panache of a scientific vocabulary.

Max Nordau in his book *Entartung (Degeneracy)*, 1892) linked the idea of degeneracy with the thermodynamic heat death. This book contains moralistic attacks on so-called “degenerate” art, as well as on the rapid urbanization and its perceived effects on the health of humans. In the United States, the writings of Henry Adams in his chapter *The Dynamo and the Virgin* [3, Chap.25] and in his *A Letter to American Teachers of History* [2], surveying mechanistic industrialization, created an approach to history through the Second Law of Thermodynamics and entropy. His approach left no room for optimism. Perhaps, though, the strongest, most influential statement of the decline of civilization as an inevitable entropic process, is found in the work of Oswald Spengler’s, *Der Untergang des Abendlandes (The Decline of the West)*, 1918-1922 [12]), whose comments on mathematics have already been mentioned.<sup>4</sup>

Skipping almost a century, I come now to an article of George N. Saridis (1931-2006) that caught my attention as a recent example of an attempt to understand certain societal developments along entropic lines. His conclusions have resonated favorably with numerous readers. Saridis was a professor of electrical engineering, robotics, etc., at Rensselaer Polytechnic and produced major works on control and stochastic systems. Here we focus on his article *Entropy as a Philosophy* [11] dedicated to the chemist, thermodynamicist, and Nobel prize winner Ilya Prigogine.

Saridis’ paper mentions entropy in biochemical, logical, economic systems, society. He states that an increase in entropy is generally bad and is to be avoided. He equates total equalization with a lack of progress. Com-

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<sup>4</sup>Also see [6, 13] on Spengler.

ing down to specifics, he decries the globalization of the economy, decries decreasing the gap between rich and poor societies, bad taste in literature, art, sculpture, baggy trashy clothing, rap music with “meowing bimbos on the stage,” religious fanaticism, environmental pollution, viewing them all as manifestations of the increase in entropy. Saridis’ conclusion:

“The concept of entropy creates a pessimistic view of the future of our universe. The equalization of all kinds of sources of activities is leading to the equivalent of thermal death and universal boredom of our world.”

It would seem that what Saridis has done in his article is to enumerate a variety of trends that he personally dislikes, and label them “entropic.” Refutations come easily. For example, his complaint about the deterioration from jazz to rap is ironic in that is that a century ago, the defenders of “high standards” were saying exactly the same thing about jazz. I do not like rap music, but a young informant pointed out to me that rap is, in fact, particularly complex and sophisticated in terms of rhythm, rhyme, and word play – much more so than the lyrics of most popular music and hence it is not “entropic.”

## **8. The Abasement of the Elite**

If one goes along with Saridis’ argumentation, one can add to his list by asserting that the abasement of elites is a result of the present juggernaut of entropic equalizations. Susan Jacoby, a sharp and agnostic writer of many books, one on American anti-intellectualism, considers the notion of elitism in an op-ed in the New York Times May 30, 2008 [7]. She begins:

“Pity the poor word ‘elite,’ which simply means ‘the best’ as an adjective and ‘the best of a group’ as a noun. What was once an accolade has turned poisonous in American public life over the past 40 years, as both the left and the right have twisted it into a code word meaning ‘not one of us.’ But the newest and most ominous wrinkle in the denigration of all things elite is that the slur is being applied to knowledge itself.”

Of course, we have never had pure democracy in this country. The founders of the USA did not want pure democracy and built some laws

against it into the US Constitution. Having gotten rid of European style aristocracy, they spoke rather of the “aristocracy of talent.”

In her windup paragraph Jacoby stresses this:

“America was never imagined as a democracy of dumbness. The Declaration of Independence and the Constitution were written by an elite group of leaders, and although their dream was limited to white men, it held the seeds of a future in which anyone might aspire to the highest – let us say it out loud, elite – level of achievement.”

Despite broad and increasing democratic tendencies in the USA, the situation regarding elites is mixed. Some elites meet with general approval and thrive. While special training for (say) mathematically talented children may lag, stars are recognized in the areas of entertainment and athletics. Their careers are well supported by the public. Having made strict and rather limited definitions of what expressions of talent are allowed, talented and accomplished people are rewarded disproportionately.

I should stress that the word “entropy” cannot be found in Jacoby’s article. Though I agree with her assessment, and though it would be easy to do so, there is no pressing need to connect this contemporary social degradation with the putative “heat death” of the universe.

## **9. Can the Increase in Entropy be Halted?**

Further thought along these lines suggests that though an increase in social entropy may be inevitable, it can be turned around – if only temporarily. Of course it can: by simply increasing differentiation. For example, strengthen the distinction between the alphas, betas, and gammas in our Brave New World. When computer science split off from mathematics and electrical engineering departments, entropy was diminished as was the case when the Soviet Union was split up. But why stop there? If it is important to decrease entropy, split the United States into fifty independent, mutually hostile countries. “Birds of a feather flock together” should be the motto of the entropy-diminishers of the world. But are these really entropy-diminishing cases? Can mere relabeling decrease entropy? Does it not depend on how one measures, an always debatable process in amorphous social situations?

Saridis’ solution for decreasing entropy is more cosmic and long term. He writes:

“Even though the arrow of time points forward, the theory of chaos provides new situations which gives hope for the alternatives than the thermal death and the end of the world ... Life has always been based on a differential among its elements and is necessary for its existence. Chaos, which considers points away from equilibrium, represents changes in behavior and therefore a differential in activities. It gives hopes for survival. A typical example is Darwin’s theory of evolution where biological bifurcation may serve as a case of the theory of chaos.”

Thus, in this interpretation, chaos is “good.”

An amusing sideline here is the famous thought experiment and creation of James Clerk Maxwell, known as Maxwell’s “Demon.” The Demon can restore the *staus quo ante* with no trouble at all. If asked to do so, a Maxwell Demon could unscramble a dish of scrambled eggs and thus effectuate a decrease in entropy. But wait! Deeper analyses of the experiment have shown that the Demon in de-scrambling, increases the entropy.

## 10. Conflicts with the Current Western Social Ethos

Adopting a philosophy of life along entropic lines, one is led to the realization that halting an increase of entropy runs counter to the contemporary democratic spirit. Admittedly, democratic liberalism tends to level everything; it says that “all men are equal” (if only as a slogan); it says that all contemporary art has equal value with Michelangelo and Rembrandt. It says that no child can be left behind. It inflates or equalizes grades of all sorts. Everyone gets an A. Everyone gets a prize. Any two people can get married. It promotes “Masscult.” Everything is intermingled, globalized, hence entropy increases. Therefore, as an antidote, keep women out of men’s clubs; build walls against immigration; keep the “races” pure and unmixed.

Deliberately halting the increase of social entropy can be seen as pure fascism. Indeed Oswald Spengler backed the Nazis initially as a fulfillment of his “laws of development” and the Nazis welcomed his views. (But later Spengler pulled back and balked at the Nazi racial laws.) Clever meta-historical arguments such as the invocation of entropy cannot justify fascism. Fascism is a bad theory of government in many different ways; it is incoherent, violent, unjust, and tends not to have any clear sense of what “good government” should consist of. “Fighting the increase of entropy” is not by itself a good theory of government, nor indeed a theory of government at all.

The problem, as I see it, is the difficult one of keeping a creative and sensible balance between separation and mixing.

### 11. On the Importation of Scientific Principles into the Humanities

Within science and technology, the concept of entropy has been valuable and stimulating. One of the more intriguing connections is to natural selection and its relatively recent modifications known as “punctuated equilibrium”. There, random mutations, maximizing survivability, or degree of fitness, constitute an ideal setting for entropy as the appropriate mathematical modeling function.

The concepts and methods of physics have been applied with more hope than success to the social sphere and go under the designation “sociophysics” (see for instance [5]). The story is long. Consider Condorcet (1743-1784) or Adolphe Quételet (1796-1874) who inaugurated such studies. Consider Malthus (1766-1834) on population growth, or even recent interpreters and critics of bell-curve statistics as applied to intelligence. The concept of entropy and the principle of its increase has been applied outside of science/technology to, among others, the social, the literary and artistic spheres. In these contexts, there is usually no rigid definition of the term in the mathematical sense, and the term there emphasizes variously the ideas of degradation, mixing, loss of creative energies and lowering of standards, etc.

The importation of one category into another, one science into another has been called by Aristotle *metabasis*, and he cautioned against it. “The translation of methods from one science to another leads only to category-mistakes” (Funkenstein, p.36). The application of the concepts of one field to another is often done by analogy. Aristotle’s warning is widely disregarded, often with profit, but at the very least it should be kept in mind and, instances of metabasis should be viewed with a critical eye.

### 12. Entropy as a Template for Historic Description, Prediction and Prescription

“Science is built up of facts, as a house is with stones. But a collection of facts is no more a science than a heap of stones is a house.” – Henri Poincaré.

Historiography must present a point of view, a method of analysis – call it an agenda if you will – for the mere listing of events on a time line does



not constitute history. Once adopted, such a method or such an agenda can go rapidly into a predictive mode. Over the millennia, one can distinguish numerous historical agendas. Here are a few (not all independent of one another): history as the universal sacred drama; history as a guide to conduct; history as the story of power groups; history as apologetics; history as a science. There are many such “takes.” The manifestations of history as a science have extended all the way from the numerological/apocalyptic to the entropic. One sees the former in the work of the mathematician John Napier (of logarithmic fame) who, using Bible chronology, discovered certain regular intervals and on that basis computed the date of the Second Coming. One sees the latter in Spengler’s *Untergang des Abendlandes*.

All of these methods organize raw events into a view of the world, providing description, and the possibilities of prediction and prescription; shaping our actions even as they supply faith, conviction, as well as doubt. The philosopher Karl Popper gave the name of “historicism” to grand interpretive organizational and predictive schemata [10]. To Popper, historicism is

“An approach to the social sciences which assumes that historical prediction is their primary aim, and which assumes that this aim is attainable by discovering the ‘rhythms’ or the ‘patterns,’ the ‘laws’ or the ‘trends’ that underlie the evolution of history.”

Principles such as the ones embodied in Biblical eschatology, the Hegelian dialectic, Marxism, the survival of the fittest, Ayn Rand-ism (i.e., ruthless self-interest), the wisdom of the market, the inevitable increase of entropy, would all come under this rubric. Thinking of the long run, Popper argued that

“No society can predict, scientifically, its own future states of knowledge. It follows that there can be no predictive science of human history.” [9]

There is, alas, a tendency to view what has happened to the world as the workings of a Grand Scheme, an Eternal Dynamic of the Universe. Eternal Dynamics are often proposed and formulated in scientific or pseudo-scientific language. Seduced by the success of numerous mathematizations in science and technology, “scientific” inroads into the humanities seem unavoidable. They are occasionally suggestive but often are dead ends and can even be detrimental. We should evaluate such inroads with open eyes, an open mind, with circumspection and with a substantial dose of skepticism.

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