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THE ENTROPY ARGUMENT & RELATED DREAMS OF REASON**

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Abstract

Humans beings have significant problems in being human. The difficulties are manifest in many ways but generally begin with the way in which humans relate to their environment. The potentials for improvements in these relations are great but so too are the difficulties. This is in part because of serious shortcomings in how the resources essential to human existence are conceptualized and managed. These shortcomings are similar to those raised by General Systems Theorists fifty years ago. Noteworthy successes were limited, therefore the problems continue. Herein it will be argued that the problems in humans relating to their environment lies more in their attitude about resources than their methods for managing them. The key evidence for this thesis is the manner in which we chose to interpret the entropy construct. Alternative interpretations of entropy are available, and should be experimented with. They would support radically different ideas on relationships between using resources and realizing human potentiality. It is argued that how a nation, group or individual chooses to interpret entropy is a clue to how well they will manage relations between humans and their environments. A dominant attitude is that it doesn't matter, and where it matters the consequence can be recycled. This attitude stems from an interpretation of entropy that derives from the historical ideas set by James Clerk Maxwell (1831-1879) and Ludwig Boltzmann (1844-1906). Each, in their own way, felt that entropic processes might be reversible through the input of human intellect. This humanistic scenario is consistent with the principles used since for design and construction of systems that separate humans from the reality of their surroundings, including other people. This attitude towards entropy is overtly optimistic, tends towards arrogance and is generally ignorant of processes of change, decay, time, reversibility, environmental order, and other realities of the entropic process. Systems theorists have a brief opportunity to experiment with alternative "attitudes" towards entropy, especially those coming from a more holistic vision. This allows access to a deeper interpretation of problems with how humans relate to their environment than those currently labeled under the topic of "sustainability."

Key words: Entropy, irreversibility, sustainability, humility , recycle and arrogance.

Introduction

An enduring and endearing aspect of General Systems Theory (GST) is that it offers an approach that encourages one to see relations, find connections and deal with larger systems of order. It allows and encourages a more holistic stance and alternative viewpoints. Early on,

GST recognized the critical role attitude plays in what humans see and fail to see. The GST attitude of always stretching to reach the whole has repeatedly opened up new doorways into the arena of scientific discovery and technological innovation. The GST doorway has offered significant advantages to the understanding of reality, but, somehow, the promised clarity in vision has been significantly obscured. It is argued here that this is due to the rose-colored glasses we wear as we pass through it. The GST attitude about the resources has been far too optimistic in a narrow sense encouraged by Boltzmann. His statistical mechanics, as encouraged by Maxwell's "game," allows for the possibility of entropic reversibility. This western approach to reincarnation thus allows for humans to reverse the aging process and return to life. This is not far from the GST approach to entropy that allows for negative entropy. An alternative attitude is needed. It does not need to be pessimistic, but it does need to incorporate what has been learned about entropy since the 19th century. The possibilities for coming to a new kind of appreciation about the relations between humans and the resources they require are quite exciting. In some ways this is highly consistent with the early dreams of GST.

It is important to note the importance of attitude. A belief that something is possible, as well as desirable, is a precursor to investing in making it possible. Such beliefs become a magnet for the enthusiasm and other resources needed to accomplish something. The history of 20th century science, including development of engines, radar, communication technologies, nuclear fission, microprocessors and silicon chips illustrates this. Earlier human activities were probably much the same. It is also important to note that this optimistic process sometimes becomes counter-productive. One such exception is the focus herein. It centers on the notion that entropic processes can be negotiated with, and, where sufficient intellect is available, even reversed. This has been the GST attitude since the 1950s. In this way the significance of the 2nd Law of Thermodynamics can be avoided. GST thinkers sought knowledge for overriding the scientific pessimism of entropy. They felt there were life-directed processes overriding the strictures of entropy. These came to be titled as negative entropy. The "neg-entropy" construct thus became an integral part of the GST platform. The question then becomes: Was this route to optimism justified? Did it lead to scientific discovery and technological innovation that demonstrated the existence of a neg-entropy "machine;" e.g., the discovery or creation of a perpetual motion machine?

I. The Situation

The early systems program encouraged use of what was then called a systems approach. This was a holistic response to problems seen as initiated by a scientific community that was seen as generally reductionistic in its attitude. Key to the response was the notion that problems, to be solved, need to be expanded and not reduced at infinitum. The example often given involved the "urban problem." It could not be "solved" via reducing it into constituent components of employment, crime, education, etc. It had to be taken as a whole and then reviewed against the larger jurisdictions of which it was a part (Ackoff, 1974). This platform and the agenda it suggests seemed very sound. Why then did it not achieve more? Why are U.S. cities not now

more liveable than they were in the 1970s when this approach was proposed? Why has this general theme not had more success in improving the human condition?

One reason for limited success may come from how the systems viewpoint perceived resources. They were simply there to be used. In this regard GST people were consistent with the analytical types that they criticized. Neither group responded very well to the AAAS challenge of Garret Hardin in 1968. He asked scientists to consider the human dilemma that results from its social systems: "Freedom in a commons brings ruin to all." (Hardin, 1998) As he recently said in Science Magazine,

"It is easy to call for interdisciplinary syntheses, but will anyone respond? Scientists know how to train the young in narrowly focused work; but how do you teach people to stitch together established specialties that perhaps should not have been separated in the first place?... With Adam Smith's work as a model, I had assumed that the sum of separate ego-serving decisions would be the best possible one for the population as a whole. But presently I discovered that I agreed much more with William Forster Lloyd's conclusions, as given in his Oxford lectures on 1833. Citing what happened to pasturelands left open to many herds of cattle, Lloyd pointed out that, with a resource available to all, the greediest herdsmen would gain - for a while. But mutual ruin was just around the corner." (Ibid, 1998)

The essence of Hardin's recommendation to those interested in the interdisciplinary approach to human problems, also the GST agenda, was to encourage those who looked for the "underlying nature of things." Hardin's initial problem with the fate of the commons, as well as his recent encouragement to those seeking the nature of things can be addressed by looking more deeply in the entropy concept. Early opponents of GST were mainly upset with the interdisciplinary approach it espoused, but often had little trouble with the specifics of its agenda. This should have been a danger signal to GST. It should have upset its enemies more than it did. This could have happened if GST people had approached entropy in a more controversial way. Some of GST's great potential has thus been lost. Fundamental changes within issues, and not between issues, as asked for by Rapaport and Boulding, were ignored. For example, Boulding proposed an attitude towards human economic activities that would dampen the enthusiasm for competition and increase concern for resources going into the socio-economic systems. He felt these should be considered valuable and scarce, and that the externalities of their use should be factored into their value. This attitude was dropped in favor of the notion that there was a negative entropy possibility; i.e., resources could be recycled, or even created.

Most systems theorists presume that "living" systems have the possibility to defy the entropic process. This presumption has been troublesome to the validity of the approach but we have a chance to reconsider it as we consider the role of systems thinking in sustainability arguments. I believe much of the discourse about, and proposed solutions to, the sustainability issue returns us to the limits and problems in belief in the possibility of negative entropy. The sustainability issue can be a doorway into reevaluation of the deeply seated issues in how humans perceive

and act upon relations to their larger environment. Three possible keys to that door are offered in understanding the resource nature of : energy, information and materials, and then how all three are subject to the entropic process. This could provide a stimulating and rewarding approach to the concerns that have make sustainability an interesting topic. This would require some changes in the GST platform.

Of the founding fathers of the General Systems Research Society, Gerard and von Bertalanffy were prone to accept the attitude that life was essentially in opposition to entropy. As mentioned before, others were not so convinced that this was correct but the optimism this attitude seemed to offer was too great a prize to be ignored. Boulding was resistive because he was worried about the consequences of resource use, not whether resources were infinite or finite (Laszlo, 1972). None-the-less the possibility of neg-entropy was widely adopted as a key tenant of the Society's thinking. Essentially all of the second generation systems thinkers adopted this stance with enthusiasm. This list includes some of the most noteworthy people from many important disciplines. During the seventies the systems approach was in such good currency that some potentially problematic baggage, e.g., neg-entropy, was allowed to join its noteworthy assets. During the eighties, when systems thinking suffered a lack of perceived relevance, there was a chance to renew and remake part of the foundation of systems thinking. In some respects this has happened in the nineties with the systems framework now seen as a critical framework for making sense of human dilemmas. Most of the interesting science now takes place outside discrete disciplines and university departments. Still, the entropy issue awaits attention by systems scientists. The role of neg-entropy relative to closed and open systems has to be rethought relative to what is now known of the prevalence of entropy processes in the micro and macro universes.

The choice between entropy as natural pessimism or negative entropy as human optimism continues. The scientific proposals to ignore the degradation association with human activities while being able to bootleg quality and most probably wrong. This can be seen in three resources areas covered in the original GST thesis: energy, materials, and information. The essence of the optimistic perception was that these do not necessarily degrade with time, that the costs associated with their use can be avoided, and, depending on the user, Maxwell's Demon can be brought in as an ally. The socio-economic implications of this are easy to trace through modern societies. The consequences for larger environmental systems, as well as the societies involved, can also be traced. The sustainability issue is another way of addressing the early implications phase of this inquiry. GST has some trouble in addressing this issue. In part its a credibility issue, but it is also a knowledge base issue. Early developers of the systems perspective used entropy in a way that does not stand up to scrutiny. They took the concept from its use in the more pessimistic world of energy/material based phenomena, and pushed it into the metaphysical world where the rules were ambiguous. From their platform they argued how in some spheres of thought entropy could be managed, and sometimes even reversed. A logical framework was construction where operations of the metaphysical world were not subject to restrictions associated with processes of decay and disorder. Eventually these dreams of reason found their way into the perception of the physical world.

GST researchers began to argue that life forces stood in opposition to entropy processes. Some of the followers of GST then expanded the logic to include social phenomena as a life force, while others expanded this dream further to include all artifacts that humans “created.” A few even re-entered the domain of physical energy/matter with their new-found optimism to argue that all socio-economic-technological processes could stand up to and perhaps even defeat what was termed entropic decay. As systems theorists now give their thoughts to the sustainability argument they should reformulate the early GST position on entropy. It can be seen how definitions of sustainability change dramatically depending on how entropy is defined, delimited or denied. Other areas of science have demonstrated that the entropy process is clearly not to be denied. It would help for GST to avoid some of these uses of the entropy concept, e.g., social entropy, while clarifying its approach to entropy where it matters.

II. The Entropy Dilemma and its 19th Century Roots

The speculation of pre-19th century scientists came together in the 19th century around the issue time and things over time, and their noticeable asymmetry. Two kinds of asymmetries were noted. First was time itself and the other was with regard to things over time. William Thomson (1824 - 1907) dealt with the first in his elaboration of “the universal tendency of entropy to increase.” (Thomson, 1852) while Rudolf Clausius (1822-1888) brought meaningful technical articulation to the second via the theory of the internal combustion engine. From this point an argument ensued as to whether or not the nature of time and things is symmetrical? In other words, are natural processes reversible or not? Since that time most branches of science took a decision about the related issue of order over time, and whether the process is reversible.

While the physical evidence has been on the side of absolute irreversibility there has been a metaphysical, mostly humanistic, faith that parts of the world have a reversible ordering principle; especially those parts to which humans can apply their creative energies. Most religions are based on the potentials allowed by this belief. Credit is given to Boltzmann for taking the Second Law of Thermodynamics from its exceptionless nature to one that is instead statistical. The problem that plagued Boltzmann until the end was that if entropy is reversible then why is entropy not higher in the past?

The debate continued through the work of Karl Popper (Popper, 1956) into the work of Davies, (Davies, 1974) to that of John Preskill, Kip Thorne and Stephen Hawking. The last three recently made a bet relative to the validity of the entropy law within the universe relative to behavior in corners of the universe. This deals with the general acceptance that the law holds at the universe scale but may not need to in isolated corners. As was reported on their recent meeting where they placed bets on where and when it held. The discussion was on what happens to information when it runs into the bottomless pits in the universe called black holes?

“Dr. Hawking and Dr. Thorne bet that the information - whether consisting of letters, numbers, the binary digits on a computer disk or even the arrangements of atoms in a rock - is gone forever. Dr. Preskill wagered that it could not possibly be.”(NYT, 1998) The essence of this argument gets to the fundamental differences between relativity and quantum mechanics. It seems that one will need to be modified to explain the entropy at black holes. If this argument sounds familiar it should.

Some recent research helps resolve aspects of the entropy debate. It deals with the paradoxes raised in the 19th century and sets the stage for implications in the 21st century.

Beginning in 1981, an IBM researcher, Charles Bennett, gave resolution to the dilemma of Maxwell’s Demon by showing how a perfectly efficient engine was impossible not just in fact, but also in principle. He showed how even Maxwell’s “demon” must expend energy in the process of becoming sustainable via “saving” energy. The “demon” has to forget each transaction prior to the next encounter. Relying on work by Rolf Landauer some years before, that the only steps in computation that necessarily produce waste heat are erasures of information, Bennett could show the perfectly efficient engine to be impossible. One caveat remained in the dilemma posed by Maxwell. Bennett’s proof relied on classical physics thus there remained a shadow of doubt relative to entropy’s operations in the realm of quantum mechanics, and then of course within statistical thermodynamics. In a 1997 Physical Review article by Seth Lloyd of MIT it is shown that in the wholly quantum world the “demon” is even less efficient than he was in the classical world.

The general issue of the nature of the entropy law is thus settled. It holds. It is now time for GST to reconsider its long-standing reliance on the existence and authority of negative entropy, and then move on to the implications of the authority from entropy. This is a fundamental shift. It can be done along with considerations of how GST can aid with the problems posed by sustainability of relations between human actions and their environments. In light of the entropic process behind humans what can truly be considered as “sustainability” in what humans produce, consume, and do. Perhaps the term should be replaced with terms that deal more with the efficiencies of the relationships. Perhaps there is no possible equilibrium since there may be no possible stable state. Perhaps there is too much human arrogance in the entire sustainability dialogue.

This would also call for reconsideration of distinctions between open and closed systems, and what their rearticulation might mean for understanding systems of living order. Perhaps we could begin by returning to the distinctions as they were initially made by Ludwig von Bertalanffy.

“Thermodynamics expressly declares that its laws apply only to closed systems. In particular, the second principle of thermodynamics states that, in a closed system, a certain quantity, called entropy, must increase to a maximum, and eventually the process comes to a stop at a state of equilibrium. The second principles can be formulated in different ways, one being that entropy is a measure of probability, and so a closed

system tends to a state of most probably distribution...So the tendency towards maximum entropy or the most probably distribution is the tendency to maximum disorder.

However, we find systems which by their very nature and definition are not closed systems. Every living organism is essentially an open system. It maintains itself in a continuous inflow and outflow, a building up and breaking down of components, never being, so long as it is alive, in a state of chemical and thermodynamic equilibrium but maintained in a so-called steady state which is distinct from the latter.” (von Bertalanffy, 1968)

The distinction between open and closed systems has proved to be beneficial to a fundamental understanding of relationships between entities and their environments, but it is perhaps unfortunate that the entropy concept was introduced to assist in the ordering of these relationships. It is clear that entities find a means to interact with their surroundings and in so doing come to define themselves by defining an environment. Angyal formulated this process quite clearly in his early work on systems theory. The unfortunate aspect relates to a weakness in rigor and result that stems from needing to associate the metaphorical aspects of systems with the entropic aspects of their environments.

III. Negative Entropy as an Obstacle to Improved Environmental Relations

Work began in Spring, 1996 on a grant from the U.S. EPA, Energy Star Program that soon encountered the entropy problem. The project began with an alternative conceptualization of problems in the relationship between humans and their environments. The project is to be completed by the Winter of 1999.

The project objective is to see if an industry can be changed without it being directed to change, or forced to change via legal orders and administrative regulations. The question was: “Can an industry generate information and processes to improve the relations between its products and the larger environment? The industry is the one that builds homes within the U.S. While often ignored, this industry’s products directly account for about 30% of the energy consumed within the country, as well as a related amount of the nation’s air pollution. Indirectly, via the location and situation of the products, it may account for another 20% of the nation’s pollution problems. As most consumers know, the industry’s products are generally of low quality as measured against those of other industries.

It was considered technically feasible to cut energy use and pollution from the industry’s products in half yet early studies pointed out that it was not politically nor economically feasible to use regulation to attain this objective. The directive agenda had been attempted via DOE energy “guidelines.” The states and municipalities resistance was stronger than the political will

to use force. Most considered the costs of enforcement to be prohibitive. Thus, an alternative approach was thought to be needed to achieve some of the Rio agreement objectives.

The direction was related to my 1970s research and dissertation in systems sciences on methods for regulating environmental protection. The essence of that work had argued that a non-regulatory, non-directive approach to self-regulation of pollution externalities was needed. The research found that there were no good guys or bad guys in the area but there was a great deal of bad information (ignorance) and bad feelings (hatred and mistrust). To turn this around the normal policing function had to be turned into an information function that would not direct behavior but encourage the behaviors of learning and adaptation. The situation of pollution could then be turned from a legal orders system to a negotiated order solution. This was the basis for the 1996 Energy Star Homes experiment.

The project has been moderately successful except for a major attitude dilemma. While about three hundred producers are now taking part in achieving the much higher standards required for this labeling program, and several thousand houses are built, there is a major obstacle to the change efforts. It centers on the entropy dilemma as outlined above. The dominant attitude is that it doesn't matter what humans do with materials and energy, as they are so smart they can override difficulties that may arise later. In other words, the dominant belief system is consistent with faith that there is negative entropy out there someplace to rescue them. Some producer via geo-thermal heat pumps, solar collectors and PV roofs will find a way to bring us perpetual motion houses.

Most home producers and consumers feel there are more than sufficient resources for making and operating homes, and where there are problems with shortages or sufficiently low quality as to require replacement the solution lies with "recycling." In other words, wherever the entropy argument comes up in the project the solution is always with recycling. Thus, "It doesn't matter what we do or buy."

The biggest block to this non-governmental, no-cost project is to find ways to inform the public as to why it does matter what is produced, how it is produced and when and where it is consumed. This is the same general problem that GST must soon confront if it is to find a helpful way to conceptualize the problems of sustainability. When this is done it will help many other action research endeavors that know change is needed but are unsure as to how to articulate its objectives. The Energy Star initiative is one of these.

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