ENTROPY AS A PHILOSOPHY

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Dedicated to Ilya Prigogine

PREFACE

The ancient Greeks considered philosophy as the mother of sciences engulfing the essence of all human achievements. It is therefore, natural to associate her with elements of universal scientific developments. The intention of this article is to present the current point of view of the situations governing our planet, our societies, our environment, and attempt to foresee their future developments**.** Entropy, the thermodynamic measure, is an analytic tool that may serve to evaluate phenomena that dominate our lives, and therefore belongs to the realm of philosophy. Since the trends show a universal trend for equalization, like the concepts of codification and globalization, an increase in global entropy is appearing as an obvious result. Is this going to create an "equivalent thermal death" to our planet? Is there a cure to this phenomenon? The recently developed theory of Chaos, introduced by Ilya Prigogine gives us some hopes for a possible redemption of this catastrophe. This will be discussed scientifically in the sequel, by considering the various elements of our present situations.

1. INTRODUCTION

The creation of the Universe and the mystery of life have always been problems puzzling the philosophers. Technological progress and the increasing knowledge of the elements of the environment have not considerably improved their beliefs. With the years a feeling of uncertainty about the Universe and the human existence has been generated and recently has become more pronounced.

Young people ask questions about God, our past and future existence and in general, how much control we do have on our lives and our environment. The world exists the way we see it and the models we have produced are inadequate to generate any positive answers. This creates a chaotic situation in the minds of the thinkers, desperately trying to create a viable model of the world that explains the past and predicts the future.

Since the early days, when human thought was developed, many attempts were made to systematically formalize the human activities in the Universe. Biological, Societal, Religious, Scientific, and Legalistic theories, to mention a few, were created independently; to model and represent the world we live in. Most of those were dealing philosophically with believes, that were created by the people in the form of irreversible phenomena.

Philosophy was always the main source and foundation of progressive theories. Ancient Greeks considered it as the mother of all sciences. It was always considered as a source of global energy. The historian Thucydides said "[illegible]. " It is the ground of development of clear modern thought both scientific and literary. It is in this aspect that will be used in the present document to describe our world.

In our days with the development of computer science scientists from different areas were able to communicate with each other end establish analytic models that approximate the behavior of various phenomena to the degree that we presently understand them. Therefore we hear biologists talk about models of DNA, ecologists about models of the environment, sociologists about globalization, thermodynamisists and mechanists coordinating their efforts, and so on and so forth. Analytic approaches to describe human activities appeared also in the world of literature. Such models, still at a primitive stage, are considered around the equilibrium of each process, and obey certain laws that are emanating mainly from physics, the science that started it all.

There is a notion of pessimism in this approach generated by the second axiom of thermodynamics where entropy invokes the **thermal death**, for all natural activities. Is this argument valid or it is assumed due to the closeness to the natural equilibriums? May be when we move away we may encounter a regeneration the way that Prigogine proposes with his theory of **Chaos**. There is still hope for our world.

However, little has been devoted to the concept of energy as the source of generation of such activities. Entropy, an irreversible source of energy, that like life itself, looks like a strong candidate to describe the phenomenon of the Universe and belongs to the philosophical framework. This claim is also justified by the conditions of disorder and tastelessness that exist in the modern world. This of the entropy formulation will be elaborated in the sequel.

2. WHAT IS ENTROPY

In the modern times one may extend the concept of philosophy to cover entropy, the low level energy, which results as a terminal by-product of any kind of effort created in most cultures. **Entropy** has been defined as the residual irreversible energy generated in thermodynamics (Boltzmann 1872), and has been extended by Prigogine (1980,1996), Saridis (1995) et al (1988,1957), to denote the energy of the probabilistic view of the world. Such a concept is very popular in modern science, and expresses the uncertainty of the model of the world we have created. Since the idea of a probabilistic world is generic, with an "arrow of time pointing forward" (Coveney and Highfield 1990), it may cover most cultural activities it may also be interpreted by a **Global Philosophy**.

For centuries scientists theologians and sociologists were arguing that the world is deterministic. "**There is always a beginning and an end of the world**" they said, in an anthropomorphic way, since life has a beginning and an end. This includes the modern theory of the "Big Bang" as the creator of the universe. However, life and the world in general, represent irreversible phenomena. Without trying to interpret dogmatically metaphysical phenomena, scientists tried to build analytic models of the existing world and found only crude approximations to match reality. The alternative was the assumption of a probabilistic description that fitted best the data.

The physicist Clausius discovered this low quality energy, which appeared in the second law of thermodynamics and was named Entropy. According to this law the production of work is followed by the production of residual energy that irreversibly increases the total level of the lower quality energy of the world. This phenomenon would lead to the exhaustion of the useful energy, preventing the creation of new useful work, thus creating a thermal death of the world. Boltzmann used entropy to study the behavior of gases (Boltzmann 1872, Prigogine 1996).

Entropy was given a different interpretation of by Claude Shannon (1963), as a measure of uncertainty in information theory related to telecommunication systems. This interpretation was used by Saridis (1995), to introduce a theory presenting Automatic Control as a generalization of the theory of entropy, based on the designer's uncertainty to obtain the optimal solution. This concept is hereby extended to cover subjects related to the environment, finances, pollution and other problems that puzzle our present society.

3. FOUNDATION OF AN ENTROPY MODEL

The contribution of this work is the introduction of uncertainty to the Universe, and to effectively restrain the growth of the Global Entropy, created by the human intervention with the environment. Since the text is addressed to the unspecialized reader, an attempt will be made to introduce first the probabilistic concepts of our cultural systems.

It is not the intention of this effort to challenge the question if the world is either deterministic or random. Instead in my opinion it recognizes that the models we use to represent it are uncertain, being only an approximation of the real world. It is well known that "Mother Nature does not read mathematics".

The model of the world I propose is based on the idea that the world lives in an uncertain space of approximations, where every point is assigned a probability of success based on some performance criterion. The selection of the appropriate model is based on the point in space of highest probability.

Modern technology, has greatly contributed to the improvement of the quality of human life, and to explain various phenomena of our cultural environment. At the same time, it has increased the production of waste, traffic congestion, biological pollution and in general environmental decay, which can be measured by the increase of the Global Entropy of our planet, an energy that tends to deteriorate the quality of our environment (Brooks and Wiley 1988, Prigogine 1980, Rifkin 1989). This entropy, in agreement with the arrow of time, is modeled according to the second law of thermodynamics, which is an irreversible phenomenon of generation of low quality energy.

The original idea of using entropy to describe the deterioration of the quality of energy, when useful work is produced, is due to Boltzmann with his monumental work in statistical thermodynamics (Boltzmann 1872). Shannon {1963) followed with the introduction of entropy in his information theory. Accordingly, Brooks and Wiley (1988) recommended entropy as the unifying theory for Biological Evolution, and Rifkin (1989) suggested the use of entropy to measure the production of waste in environmental systems. This concept is utilized in this paper in order to manage its component due to human functions.

Saridis, using Janes' principle of Maximum Entropy (1957), formulated the engineering design problem as a problem with uncertainty, since the designer does not know a-priori the outcome of his design (Saridis 1995). Entropy was used as the measure of the energy associated with the assumption of irreversibility of the process. This way the optimal control problem was recast as an entropy minimization problem and the known expressions were reproduced.

In addition Saridis, working on the problem of reducing analytically the increase of entropy generated by human intervention in global systems, added an extra term to the equation of work producing systems, and used optimal control to minimize the effect of the resulting entropy. The combination of the two approaches produces an analytic method of reducing the part of global entropy due to human intervention with the environment.

4. THE PROBABILISTIC VIEW OF THE WORLD

A formal presentation will be made, of the probabilistic approach developed from an entropy point of view, and thus present a method to minimize its effect to our cultural systems. This theory has in addition to the practical applications, a philosophical foundation that has implications to the quality of life and the future of our planet. Experimental results are due after the collection of data from environmental systems.

Global Entropy, associated with irreversible phenomena, appears when we consume energy in order to accomplish some work in our environment we simultaneously create a low quality residual energy, that irreversibly reduces the quality of the environment and leads to a chaotic situation. An infinite number of paradigms exist in our environment, starting with the pollution of the air and the water resources, increase of the waste areas, traffic congestion, financial disasters, unemployment with the resulting crime, and in general the decay of the life-sustaining resources of mankind (Prigogine 1980).

Entropy in our cultural environment has been introduced through our modern technologies, as an energy producing work, like the latest major improvements in the average quality of life. These are producing major increases in the production of waste, traffic congestion, biological pollution and in general environmental decay, which can be interpreted as the increase of the Global Entropy of our planet, an energy that tends to deteriorate the quality of our present environment. According to the second law of thermodynamics this is an irreversible phenomenon, and nothing can be done to eliminate it. Brooks and Wiley suggested entropy in Biological Evolution (1988), while Rifkin used entropy as the measure of decay (1989), and Faber et. al. (1995) propose Entropy for Economic systems. However, other major cultural areas of thought, like societal systems, religion, legal and governmental theories have not kept up with the technological achievements, and therefore are missing in benefits due to the lack of appropriate models for their study. The theory of Entropy, if introduced properly, in addition to its practical applications, has a philosophical foundation that has implications to the quality of life and the future of our planet.

There exists a huge literature with analytic formulations of the problems that concern modern societies, like ecology, environment, biochemical systems, econometrics, and other applications. A good summary of those systems can be found in Singh's **Systems and Control Encyclopedia** (Singh 1987) which served as a source for the development of the material associated with the application of Optimal Control for the reduction of the Global Entropy generated by the work produced by humans in order to improve the quality of life.

The analytic models considered here are for;

- Art
- Biological Systems
- Biochemical Systems
- Ecosystems
- Engineering Systems and Manufacturing
- Environment and Pollution
- Phenomena in Modern Science: The Universe
- Religion
- Socioeconometric and Political Systems
- Societal Systems

In most of these cases, the models have been modified to introduce the human effort as a random control variable to be optimized. Such an approach presents as a solution the possible improvement of the problem of decay. These models may not be the most general or the most popular ones, since controversies exist among the various researchers, however they are representative to demonstrate the idea of improving the quality of our world by reducing the entropy generated by the work produced.

5. "CHAOS" AND THE WORLD DYNAMICS AWAY FROM THE EQUILIBRIUM.

Assuming the analytic model for human activities, the theory of **Chaos**, or the dynamic behavior of nonlinear dynamic systems away from the equilibrium, developed by Pigogine for biosystems originally, came to assist modern scientists to expand the analytic concepts to other cultural phenomena.

From their primitive years, humans have tried to understand and formalize the world around them, through the sensors that nature provided them. To do this they have used various models to represent "approximations" of the functions of the world. They separated those functions into two categories governed by:

1. The Physical Laws of Nature describing deterministic physical phenomena, and
2. The Behavioral Laws describing non-deterministic organic, environmental and societal phenomena.

For the first class, linear mathematics proved to be a concise methodology to approximately describe the time-reversible results of physical experiments near their equilibrium. Logical (Aristotelian) analysis and statistical exhaustive search, were the methodologies used to classify and study the evolutionary behavior of living organisms, environmental and ecological changes and societal phenomena that demonstrated time-irreversibility known as the arrow of time (Brooks and Wiley 1988, Prigogine 1989).

In the recent years, with the progress of the mathematical science and the development of digital computers, probabilistic and stochastic methods and analytic logic are replacing statistical aggregation and classical logical analysis in the realm of mathematics to describe the world's phenomena. Linear analytic models were assumed to be sufficiently accurate to represent useful models of this world, as viewed by human senses. "Reductionism" that has been a powerful tool to analyze and predict physical phenomena, was promptly extended to cover natural phenomena for description and prediction of their behavior. The deterministic model evolved on the principles of the Newtonian mechanics.

However, there were cracks in this wonderful and supposedly airtight, reasoning system. Physical discrepancies and analytic paradoxes marred the perfect models that the world thought infallible. One of the major difficulties encountered was the gap between Newtonian mechanics and thermodynamics. Scientists discovered that heat was produced by the collision of millions of particles in a perfect gas, generating irreversibly entropy, a lower level of energy. However, Poincare showed, that it is practically impossible to study the motion of more than three bodies and thus understand the process. Boltzmann(1872) bridged this gap by introducing statistical methods to describe kinetic phenomena and equate their average kinetic energy with entropy. This pioneer work showed a way to model uncertain and complex physical phenomena in continuous time and connected them to irreversible evolutionary models described by Darwin (Brooks and Wiley 1988), and Shannon (1963) followed with his celebrated **information theory**.

Prigogine (1989) after observations on biochemical phenomena, studied the behavior of dynamic systems away from their equilibrium, a procedure which led to their nonlinear behavior. Jump phenomena led to possible nonunique alternate situations that would converge to a static equilibrium with linear behavior. Therefore, it explained the unrealistic transition from order to disorder as interpreted by the disciples of determinism. This originated the theory of **Chaos** proposed by Prigogine.

Saridis (1995), in the meanwhile, using Jaynes' principle (1957), formulated the engineering design problem as a problem with uncertainty, since the designer does not know a priori the outcome of his design. Entropy was used as the measure of the energy expressing the cost of the irreversible associated process. Considering control as the work and entropy as its cost, the optimal control problem was recast as an entropy minimization problem and the known expressions were reproduced. The cost of the reliability of the design was also expressed as entropy, and was considered as a natural extension of the proposed theoretical development.

Major problems regarding the completeness, consistency and decidability of a statement in a discrete event space, arose with Gödel's theorem of undecidable statements that limited the use of digital computers for the analytic solution of complex problems. Such problems existed with the Diophantine equations and other paradoxes but they were swept under the rug, so that they would not challenge the power of the computer. Such problems were remedied by introducing new quasi-statistical engines like artificial intelligence, fuzzy set theory and other such techniques. All those problems were blamed to the inadequacy of linear models, and the complexity of systems operating away from the equilibrium point like most of the biological, environmental and societal systems do. Thus, the theory of Chaos was introduced by Prigogine (1996) to study and analyze such cases. The benefit of these discoveries was that complexity and undecidability brought all these problems together and global formulation of their solution was sought. Uncertainty, which is indirectly associated with time irreversibility, was the common element representing the doubt of the outcome of such systems, and stochastic approaches were introduced which have entropy as a common measure.

Thus, the uncertainty of modeling of complex systems is the reason of introducing entropy, in Shannon's sense, as a measure of quality of large complex continuous or discrete event systems. In essence, since entropy is energy irreversibly accumulated when work is performed, and originally introduced in thermodynamics, it is generalized to any kind of dynamic system appearing in nature. Therefore, entropy measures the waste produced when work is done for the improvement of the quality of human life, the struggle of the species in an ecosystem, the biological reactions of a living organism, even the politics of in a societal system. Entropy assumes a stochastic model with uncertain outcome, which is suitable to describe the new complex model of the world.

The theory also gives us a hope that there may be a way out of the accumulation of entropy which may lead us to the **thermal death**.

The question now is if and how this model and the underlining systems, can be improved, by reducing the waste of energy represented by entropy, using analytic methods. Concepts from control theory, used the introduction of a control term in the analytic model, has been proposed to solve this problem.

6. APPLICATIONS

6.1 Biochemical Systems

Prigogine(1980) in his work "**from Being to becoming**" identifies chaotic phenomena in certain biochemical reactions away from their equilibrium. Since these reactions are irreversible he characterized them with lower level Entropy. Experiments like the Belousov Zhabotinskii have established the value of chaotic behavior of chemical reactions.

6.2. Biological Systems

Biological systems produce work through their lifetime. This generates Entropy expressed by the energy of decay of the system. Aging and the deterioration of the human body, diseases and organic decay are typical examples of various forms of Entropy. Medicine has being struggling to reduce their effect by optimizing the duration of human life.

Scientists in Biology stared understanding the models of DNA and are simulating them on digital computers. The resulting models, although primitive are attempting to construct and explain the structure of living organisms. DNA is a map of human heredity. Cloning, with the use of DNA has been used for biological preservation. Transplants are typical examples of an optimal control process. They may represent alternate solutions related to Chaos. This gives us hope of reduction of the biological Entropy.

6.3 Ecosystems

The energy produced by the work of living organisms generates Entropy in the form of decline of reproduction of species and the decay of their environment. This may be measured analytically, by the entropy which expresses the irreversible residue of low level energy. The phenomenon of such devastation is obvious in the environment which is full of waste dumps and barren land where various endangered species used to live. It is really heartbreaking to look at lands, which were full of life and energy to appear barren and desolate. The plants are replaced by waste, the living creatures are gone forever and the ponds have turned into swamps. Wetlands are filled with poisonous waste, while floods take place due to constructions in ravines. There is of course recycling as a control measure of the environment. However, this is only a temporary
solution since the total entropy of the system still increases even at a slower rate.

As mentioned above, Saridis (1998) working on the problem of reducing analytically the increase of entropy generated by human intervention in ecological systems, added an extra term to the equation of ecosystems and used entropy formulation of optimal control to minimize its effect. However, this is only a temporary solution and not an answer to the question.

The problem is devastating since, as they used to say, there is no more room "to go West" to conquer new land. There is of course the outer space to go and pollute, but this technology is still many years away.

6.4 Entropy and Religion

Religious fanaticism is a scheme that produces pointless work. As a result it generates material destruction, mental agony, pros elitism and contempt to human life all variations of mental Entropy. This phenomenon has existed throughout the centuries as a by-product of human weakness to face the realities of the world.

There is a revived effort by the clergy of all persuasions to attract and proselytize more faithfuls with after life promised rewards. Absolute brainwashing with dogmatic overtones has been demonstrated all over the world, especially in the Moslem religion. Kamikaze bombers have created religious terrorism. The value of human life is thus reduced by the promise of sanctitude. "Religion is the opium of the world" said Karl Marx.

The problem is not a privilege of Islam. Other religions, including Christianity, are encouraging low level emotions. Masses are drawn to hysteria in order to chase away the scare of death. Buddhism is an exception to such a craze.

Unsuccessful attempts to equalize various religions, e.g. Christianity, help to increase the entropy of belief. Could the theory of Chaos if applied, relieve humanity of such a disaster?

6.5 Entropy and the Society.

Modern society is getting more structured and more dynamic. On the other hand, ethical and moral deterioration is getting more pronounced in our present days. A formal presentation of an entropy theory to describe the ethical and moral decay of our times is considered. It is developed from an entropy point of view that relates optimal control theory to the Global Entropy, and thus represents a method to minimize its effect to our society. This theory has in addition to the practical applications, a philosophical foundation that has implications to the quality of life and the future of our planet. Experimental results substantiate this theory.

Since the urbanization has dominated our social dynamics the lowering of the quality of our societies has begun. Migration of the members of the poorer societies to the richer ones have been the cause of this deterioration by introducing lower quality life in congested neighborhoods, and cheaper workforces which lower the Entropy of the system.

The decay of the family ties is characteristic of the modern society, due to busy parents. Their lack of generates loneliness and anxieties to both the parents and their children. Stress appears as a result which leads to drug addiction and suicide of the young people. The multimedia contribute more to the decay of family life.

The newly introduced concept of **globalization**, which intends to decrease the gap between rich and poor societies, may be viewed as a method of equalizing resources of the world thus increasing its total Entropy. Further more it exploits the working class by monopolizing the marketed products.

6.6 Entropy and the Art.

Entropy measures the residue energy of generation of the atrocious modern art of our times. The age of cheap and bad taste for painting, sculpture, literature, clothing and other forms of art has been dominant.

Paintings like the ones produced by a well known modern Greek painter, the 2004 Olympic mascots, sculptures like the moving part ones or made of scrap metals and literature like the trashy memoirs of the so called celebrities of the year, are tasteless products of our times.

Music like "rap" which replaced jazz in the black culture, the screechy singers and the "meowing" bimbos on the stage are another example of the lowered quality of art. Meaningless songs are filling the air. Baggy trashy clothes that the modern artists of the stage and fashion show models are wearing are all cheap and tasteless.

Their low quality taste, are **Kitsch** which represents the new form of Entropy in modern Art.

6.7 Environmental and Pollution

The energy of accumulation of pollutants in the environment and its decay is next in the list of entropy generating agents. Poisonous chemicals, non-biodegradable plastic products, nuclear waste, are accumulating on our lands and seas that kill life producing organisms and are emasculating Mother Nature.

Modern technology has greatly contributed to the improvement of the quality of human life. At the same time, it has increased the production of waste, traffic congestion, biological pollution and in general environmental decay, which can be measured by the increase of the Global Entropy of our planet, an energy that tends to deteriorate the quality of our environment. Accordingly, Rifkin (1989) suggested the use of entropy to measure the production of waste in environmental systems. This concept is utilized in this work in order to manage its component due to human activities.

Entropy was used as the measure of the energy associated with the assumption of irreversibility of the process. The methodology of using Entropy with Automatic Control, produces an analytic method of reducing the part of global entropy due to human intervention with the environment. Again Saridis' approach to minimize their effect through analytic optimization methods is not sufficient to eliminate the problem. As in the ecosystem description one has to think of moving to other planets to find clean environments.

This approach contributes to the introduction of the entropy approach of optimal control theory, to environmental systems, to effectively restrain the growth of the Global Entropy, created by the human intervention with the environment.

6.8. Manufacturing and Engineering Systems

The evolution of the digital computer in the last thirty years has made possible to develop fully automated systems that successfully perform human dominated functions in industrial space, generating waste interpreted as entropy with automation as a major factor in modern technological developments. It is aimed at replacing human labor in

a. Hazardous environments,
b. Tedious jobs,
c. Inaccessible remote locations and
d. Unfriendly environments.

Automation possesses the following merits in our technological society: reliability, reproducibility, precision, independence of human fatigue and labor laws, and reduced cost of high production (Valavanis, Saridis 1992), with minimal human supervision, leaving humans to perform higher level jobs.

Manufacturing on the other hand, dedicated to make or process a finished product through a large scale industrial operation. is an integral part of the industrial process. In order to improve profitability, modern manufacturing, which is still a disciplined art, involves some kind of automation. Going all the way and fully automating manufacturing is the dream of every industrial engineer. However, as a work producing process, it is generating Entropy producing environmental pollution, loss of manual jobs, and marketing.

The National Research Council reacted to these problems by proposing among other items a new discipline called: **Intelligent Manufacturing** (The Comprehensive Edge 1989).

Intelligent Manufacturing is the process that utilizes Intelligent Control, with entropy as a measure, in order to accomplish reduction of entropy. It possesses several degrees of autonomy, by demonstrating (machine) intelligence to make crucial decisions during the process. Such decisions involve scheduling, prioritization, machine selection, product flow optimization, etc., in order to expedite production and improve profitability and creating non-recyclable products which contain entropy. A case study of Intelligent Manufacturing dealing with a nuclear plant may be found in (Valavanis, Saridis 1992).

At the present time the application of such technology, even though cost-effective in competitive manufacturing, is faced with significant barriers due to (The Comprehensive Edge 1989);

a. Inflexible organizations
b. Inadequate available technology
c. Lack of appreciation and
d. Inappropriate performance measures

However, globalization and international competition, and the need for more reliable precisely reproducible products is directing modern manufacturing towards more sophistication with the generation of more irreversible energy.

Automated multiple product scheduling is needed when the factory produces more than one product on the same set of stations and the ordering of production must be set as a minimum operating cost scheduling problem. The problem is mathematically formulated to set the order of production using entropy as a measure in the Intelligent Control's three level structure (Varvatsoulakis, Saridis, and Paraskevopoulos 1999). The complete system is able to issue high-level task plans and use them to control the stations of the factory in the lower level of the hierarchy. The system includes a learning algorithm designed to obtain asymptotically optimal task plans for production control in uncertain environments.

6.9 Socio-economic and Political Systems, Globalization

Our societies have developed econometric (analytic) systems to measure the conditions of the economy. A typical document is the book by Faber, Niemes and Stephan (1995) that gives analytic examples of the various economic behaviors of markets using entropy as a measure. This approach indicates the accumulation of entropy that leads to disastrous global equalization of the economy.

The modern attitude of global equalization of human resources named **globalization** converges to an equilibrium point of maximum entropy, where no further progress in our planet is possible. All the nations will have the same future without any chance for growth or societal improvement. There are certain advantages in globalization, like equally sharing the wealth the food and the technological achievements of the world. However, total equalization will lead to a lack of progress and global boredom as a result of the accumulated entropy, to say the least.

Governmental corruption, favoritism, and the resulting absolutist behavior create a devastating worldwide situation. Tastelessness in the Arts and Mass Media, Globalization, and Politicalisation are main characteristics.

A characteristic phenomenon of increase of global entropy, similar to the effects of globalization, is the so called "theory of anarchy" and its followers. Their no order theories lead to a disastrous situation of global maximum entropy and the methods used to implement it are catastrophic. In theory these situations represent a total equalization of the world that gradually increases its entropy content.

In modern political ideology many systems are decaying tending to a common denominator. An example is "anarchy" which symbolizes the absolute equality and resembles the entopic thermal death.

6.10 The Sciences and the Universe.

Phenomena in Modern Physics are prominent. Is nuclear energy reversing the Entropy phenomena?

It may represent the energy of deterioration of spatial bodies, or the death of stars according to "The "Big Bang" theory.

The idea of irreversibility as the objective uncertainty of a-priori solution was introduced in the designer's problem; it was reintroduced when considering that control produces useful work on a system, which generates the cost of performance as entropy (Saridis 1985). This irreversibility is interpreted by considering that, when the cost of performance is paid, the system cannot be recovered. This property can be witnessed by visiting the junkyards of old automobiles: new cost must be paid to recover the metal of the old wrecks or in the construction of Space Stations, where the energy of space transportation cannot be recovered.

7. SHOULD WE BE AFRAID OF "CHAOS"

Entropy, as a philosophical device, gives a very pessimistic outlook for the future of our world. It represents energy and should be considered as such. **Thermal death** in all its aspects, including total equalization of our society, ecology, economy and technology, tastelessness in art, and global boredom are its characteristic predictions that the arrow of time points at.

Should there be a possible cure of the problem? Is death the end of the line? Should we hope that that a supernatural deity will give continuity to the live of our universe? Even though the arrow of time points forward, the theory of chaos provides new situations, which gives hope for alternatives than the thermal death and the end of the world.

Life has always been based on a differential among its elements and it is necessary for its existence. Chaos, which considers points away from the equilibrium, represents changes in behavior and therefore a differential in activities. Therefore, it is a device against the equilibrium and the thermal death. It gives hopes for survival.

A typical example is Darwin's theory of evolution of the species (Brooks and Wiley, 1988), where biological bifurcation of the genetic chains may serve as a case of the theory of Chaos. Another example is the perpetual energy emanating from the sun due to nuclear reactions. They both represent the defeat of thermal death and a hope for the continuity of the future of our world.

Is there a conflict of the concept of entropy with God? I do not believe so since it provides alternate solutions that we witness in life. Chaos expresses an optimistic answer to this question.

8. CONCLUSIONS

The concept of Entropy creates a pessimistic view for 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. This, according to modern thoughts (Prigogine 1996), may be due that sciences were recently considering world phenomena only close to the equilibrium. An excursion away from it, which has been developed currently (Saridis 1995) promises changes of this image. The theory of Chaos creates some hopes to reverse the catastrophe. The possibility of colonization of other planets may be the needed answer. The first steps in that direction have already been taken.

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