

Entropy: A Join between Science and Mind-Society

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ABSTRACT: Entropy is join, intersection and interaction between natural science and human mind-society. We proposed that if internal interactions exist in isolated systems, entropy decrease will be possible for this system. Management in system is a typical internal interaction within the isolated system. The purpose of management is to use regulating the internal interactions within the system, and to decrease the increasing entropy spontaneously. We propose the principle of social civilization and the developing direction is: freedom of thought, rule of action. Both combinations should be a peaceful revision and improvement of social rules and laws. Different countries and nations, different religions and beliefs should coexist peacefully and compete peacefully. The evolution of human society must be coevolution. Its foundation is the evolution of the human heart and the human nature.

KEYWORDS: *entropy, science, society, management, mind, evolution.*

I. INTRODUCTION

Wendt searched four bridges between natural science and social science: 1. Brain or cognitive neuroscience. 2. Human behavioral genetics. 3. Evolutionary biology. 4. Environmental science [1]. In sociology, there are two aspects of interpersonal relations: cooperation and conflict [2,3], which should correspond to order and disorder. Entropy is join, intersection and interaction between natural science and human mind-society. Such both are similar to entropy decrease and entropy increase at some extent.

The evolution of cooperation [4-6] is generally classified as kinship and reciprocity [7,8]. But, in fact there are many evolutionary pathways to cooperation [8,6], for example, Prisoner's Dilemma, and some games, etc. In this paper, entropy as join, intersection and interaction between natural science and human mind-society, we research management is a typical internal interaction within the isolated system, and its purpose is to use regulating the internal interactions within the system, and to decrease the increasing entropy spontaneously. We propose the principle of social civilization and the developing direction of human society.

II. THEORETICAL BASE

As in life and science, entropy is inevitable in any system. Entropy, as a new world view [9] also governs the system's evolution and human development.

So far, general people have believed that entropy must increase in isolated systems. But, its preconditions are: (1) Various internal interactions in the system must be neglected, i.e., it has the statistical independence [10] and the additivity of entropy. (2) They must be thermal equilibrium systems. We proposed that if interactions exist among various subsystems of an isolated system, in which entropy decrease is possible [11,12]. They include physics [13-17], chemistry [18-20], astronomy [21-23], geoscience [24], biology [25-27], and social sciences [28-30]. An isolated system may form a self-organized structure with lower entropy for these cases of attractive processes, internal energy, system entropy, nonlinear interactions, etc. Some possible entropy decreases are calculated quantitatively [13,16]. As long as we break through the bondage of the second law of thermodynamics, the rich and complex world is full of examples of entropy decrease [17,30].

Energy and entropy are two very important quantities necessarily considered in the development of economy and society. But, entropy is often misunderstood in some cases. We discussed the moderate degree of input negative entropy flow for open systems, and proposed possible entropy decrease due to internal interactions and transformation of internal energy for isolated systems, and obtained a total formula of entropy change [15,29].

III. ESSENCE OF MANAGEMENT

Management is defined as the process of administering and controlling the organization, and its nature, type, structure, and size. Management in system is a typical internal interaction within the isolated system. It includes much internal adjustment and control, and through them to achieve order, more efficient, competitive,

and better survive and develop. A key of management is to change the natural tendency disorganized with entropy increase and build the best system with entropy decrease. It is the thermodynamic meaning of management. Further, this theoretical mode may be extended to ecology, biology, economics, sociology, etc [31]. These systems have constant evolutions and go optimization processes with order and entropy decrease. In many social systems and the human society there are usually some non-equilibrium dynamic processes, which are accompanied by order and entropy decrease.

Based on thermodynamics in management we used the method of coevolution and self-optimization [31]. For a corporation, its self-evolution process corresponds to self-optimization, different decrement of entropy dS_A correspond to different stages of an evolutionary process, and additional phase transitions. It compares own before and after, and entropy may decrease constantly. For both similar corporations of competition each other, their decrements of entropy may compare the entropy of each corporation A and B: dS_A and dS_B . If their original entropies are the same, and $dS_A > dS_B$, a corporation A will excel another corporation B. It is the comparison between corporations each other.

The culture of group-corporate is an internal environment. A good culture can form self-organization, whose collectivism automatically creates a resultant force of cohesiveness. It is similar to magnetization. The Japanese management model and corporate culture may be studied. Management can form supernatural force, which is the internal attraction to create an orderly party, i.e., unity is strength. More generally, order is power, knowledge is power, and reason is power [31].

The main purpose of management is to use regulating the internal interactions within the system, and to decrease the increasing entropy spontaneously, which is a process with decrease entropy. From the earliest village rules and regulations to the harmony of the ideal society, from the ritual (Li) of Chinese traditional culture to the laws of modern society, from war with the disorderly competition and biggest destroy to the United Nations and world peace, they are all this case. It is consistent with Fig.1, in which from A to B, for example, from disorder to order, from war to peace, and so on [15,29]. If this system is isolated, it will correct and develop the second law of thermodynamics.

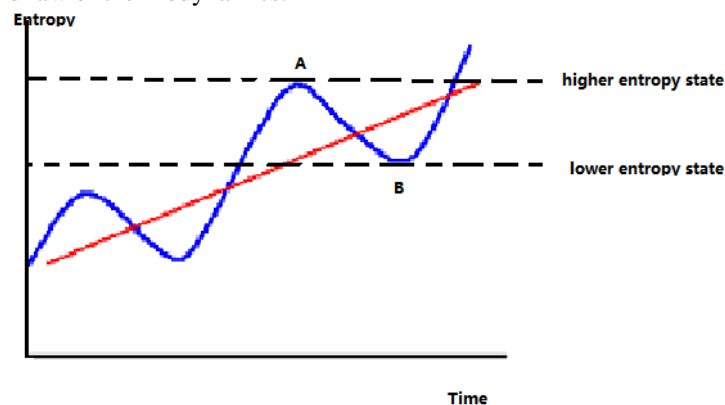


Fig.1. Transformation processes between states with higher entropy and lower entropy

Management acts as a guide to a group of people working in the organization and coordinating their efforts, and towards the attainment of the common objective [32]. The internal management in system is a classical internal interaction in isolated systems. Management and its entropy decrease are an important application of entropy decrease in the social sciences. Since the complexity of economics, the economy is closely related to many aspects of society, and this involves the expanding domain of economics [33]. Economic law is a legal discipline that studies economic laws and their development rules. For this Hirshleifer [3] searched Smith theorem [34], Coase theorem [35], etc.

Based on thermodynamics in management we may use the method of coevolution and self-optimization [27]. For a corporation, its self-evolution process corresponds to self-optimization, different decrements of entropy dS_A correspond to different stages of an evolutionary process, and additional phase transitions. It compares own before and after, and entropy may decrease constantly.

Darwinian evolution and mutual help seem to conflict each other. But, since the second law of thermodynamics is based on isolated-equilibrium systems, it is constrained. In essence, the most systems in the universe and nature are constantly changing and evolving with "life". Based on biophysics we researched coevolution from thermodynamics and entropy by a unified method.

Let the decrement of entropy dS_A of subsystem A is a set of its elements dS_i , which may include various internal interactions, and cooperation and complement each other, so that entropy may be decreased. It

includes self-evolution, competition with each other, etc. Development may combine self-optimization and self-organization. Brain control of the body is the most typical of internal interaction. No one would think that this only leads to an entropy increase. We discussed biological synergetics, ecosystems, and sustainable development. Cooperation-competition is a common phenomenon in the ecosystem. Coevolution is the more general evolution-development law of biological and active systems. It can unify natural competition and mutual help in ecology, and is an essential model for human development direction [27].

During sleep and hibernation people or animals as individuals may through internal regulation reduce metabolism with entropy decrease. In the animal world, unity and cooperation are strengths, for example, the cooperative hunting of animals. It corresponds to the mutual help theory, which reaches the competitive advantage [27]. Lotka-Volterra equations in ecology describe the period change, corresponding entropy period change. It is impossible to increase the entropy forever.

The thermodynamic meaning for the naturally formed ecosystem is through interaction and regulation within the system to reach the dynamic balance, order, and entropy decrease. For artificially intervened ecosystem this is also the same, for example, in national parks. Traditional Chinese agriculture forms a typical recycling ecosystem, and sustainable development.

IV. ENTROPY AND AIM OF ECONOMY

Economy pursues maximum interests, and market interaction tends to economic efficiency. On the one hand, laws will tend to provide assistance and supplement for this; on the other hand, laws are also self-restraint for enterprises. The two finally reach a balance. We developed the multi-connected topological economics to the multi-connected topological sociology, and researched the social field (including general relativity) and some applications. Further, the complex analysis, variational calculus, nonlinearity and a new mathematical relation are applied to social sciences [36].

General power may be divided into power within the economic system, most typically management; and power outside the economic system, which is origin of the social structure. Management should reduce or even completely block those multi-connected topologies unrelated to the economy.

In mathematics, the variational calculus may be applied to economics and various social sciences [36]. Assume that F is the inherent production capacity of economics or various social systems, G are various constraints conditions of laws and so on, H is the effective capacity of economics or various social systems:

$$H(x_1, x_2, \dots, x_i) = F(x_1, x_2, \dots, x_i) + \sum_q \lambda_q G_q(x_1, x_2, \dots, x_i). \quad (1)$$

From this we derive Lagrangians H and corresponding Euler-Lagrange equations.

$$\frac{\partial H}{\partial x_1} = \frac{\partial F}{\partial x_1} + \sum_q \lambda_q \frac{\partial G_q}{\partial x_1} = 0, \quad (2)$$

$$\frac{\partial H}{\partial x_2} = \frac{\partial F}{\partial x_2} + \sum_q \lambda_q \frac{\partial G_q}{\partial x_2} = 0, \quad (3)$$

...

$$\frac{\partial H}{\partial x_i} = \frac{\partial F}{\partial x_i} + \sum_q \lambda_q \frac{\partial G_q}{\partial x_i} = 0. \quad (4)$$

These i equations (2)-(4) and q constraints conditions, which correspond to q multi-connected topology, social evolution will reach both equilibrium and H will be maximum value. $\lambda > 0$ is management, etc., and $\lambda < 0$ is corruption, etc. Moral economy [37] is self-restraint, and economic laws are external and social restraints.

Psychologically, this is from indulging its own beast to control the heart, cultivate one's morality, and improve self. Religion, etc., are all some constraints.

Let $E=H$, and $dS = -\frac{dH}{T}$, variational calculus may be from $dS > 0$ to $dS < 0$. If the social temperature

T is invariable, so $dS > 0$ for $dH < 0$ and $dG < 0$, $dS < 0$ for $dH > 0$ and $G > 0$. For different stages, F and G and H are different. The increase of social welfare must be $dF > 0$. For the arms race, G will increase substantially.

We introduced the total economic value S_t and the free (available) economic value

$$S_{eff} = S_t - (S_{hw} + S_{dw}). \quad (5)$$

S_{eff} is S_t subtract the social waste, G includes two parts: 1) the necessary (bright) loss $G > 0$, and S_{hw} includes various transparent social welfare, government spending, education fee, defense budgets, etc; 2) dark corruption depletion $G < 0$ and S_{dw} . From this we introduce various ratios of various topologies, S_{eff}/S_t and so on. While S_{hw}/S_t is a transparency index of society, and S_{dw}/S_t is a dark index of society.

V. ENTROPY CHANGE IN SOCIOLOGY AND ECONOMICS

Sociology studies human social relationships. Its subject is diverse, from crime to religion, from the family to the state, from social stability to radical change in whole societies. These relationships are usually some internal interactions. From the solidarity of Durkheim, the association of Simmel, to the structural functionalism of Parsons and Merton, which focuses on the structures of society and their functional significance for other forms, they and exchange theory are all various internal interactions in the social systems [30]. Integration requires that a system regulates the interrelationship of its component parts. The micro-social order and a more integrative exchange theory are discussed [38].

Balch researched hierarchic social entropy for an information-theoretic measure of robot group diversity [39]. Stepanic, et al., examined an approach to a quantitative description of social systems based on thermodynamic formalism [40]. Stepanic, et al., described social systems using social free energy and social entropy [41]. Bailey discussed social entropy theory and its application of nonequilibrium thermodynamics in human ecology and living systems theory, and discussed living systems theory and social entropy theory [42].

We discussed generally the four variables and the eight aspects in social physics, and searched social thermodynamics and the five fundamental laws of social complex systems [43], in which the entropy $S = k \ln W$, where W is the number of possible states of all elements in this system. Usually it increases in an isolated system, but it may decrease with internal interactions or for an open system. Humanity as an inseparable whole on the Earth possesses a common environment and benefits. Based on the inseparability and correlativity of the social systems, we proposed the nonlinear whole sociology and the four fundamental laws [43].

We researched possible unification of some ideal social sciences. The ideal sociology, economics and the science of law should be based on ethics. Ethics and various social sciences should be based on anthropology, in particular, social anthropology and culture anthropology. Politics should be found on the science of law. Further, differences between different nations must exist for some specific rules in social sciences. Therefore, we should study universality and particularity in social sciences simultaneously [44]. In a word, the rule of law is more orderly than the no rule of law. Many social sciences are designed to develop the order of various social systems.

Ecology is closely related to the rise and fall of human society. Entropy plays an essential role in ecological economics, and the cycle of resources and the general recycling economy cannot be a single increase process of entropy. To achieve sustainable development, society must realize the recycling economy. We studied the applications of hypercycle in ecology and corresponding equations of ecosystem. The critical factor in the cycle is the conversion of waste. We proposed the talent ecology, which studies the relations between talent and social circumstances, and searched its three basic principles. The base of talent is education. The mechanism of academic development is freedom. The aim is innovation. The talent ecology must encourage intellectual diversity. The structure-function-result mode of the ecosystem is proposed. We discussed the recycling ecosystem of traditional Chinese agriculture and Chinese cultural-social ecology.

Various complex biological systems provide rich platform for study of entropy decrease [25,26]. In biology and neuroscience, the permeable membrane, the molecular motor, etc., are all some internal interactions. These and physiology, psychology, and Qigong and various practices are related to order states with entropy decrease. Entropy is applied mainly in ecological economics [45]. Daly discussed the controlled throughput by physical method at the point of lower entropy in the economics of the steady state [46]. Ayres edited book: *Resources, Environment and Economics: Applications of the Balance Principle* [47]. Swaney searched economics, ecology and entropy [48]. Hall, et al., researched the ecology of the economic process: energy and resource quality [49]. Faber, et al., searched concepts and methods of ecological economics [50]. Ayres discussed eco-thermodynamics: economics and the second law, and pointed out: The laws of physics, especially the first and second laws of thermodynamics, have significant implications for economic theory [51].

In the development of economy and society, energy and entropy are two very important basic quantities. We proposed the universal formula for any isolated system [12]:

$$dS = dS^a + dS^i. \quad (6)$$

It is symmetry with the formula in the theory of dissipative structure:

$$dS = d_i S + d_e S, \quad (7)$$

Further, we proposed quantitatively a total formula of the entropy change for the universal evolution of any natural and social systems [15,29]:

$$dS = dS^a + dS_+^i - dS_-^i + dS_i + dS_e^+ - dS_e^-. \quad (8)$$

When

$$dS^a + dS_+^i + dS_i + dS_e^+ > dS_-^i + dS_e^-, \quad (9)$$

entropy increase $dS > 0$, the system tends to disorder. When

$$dS^a + dS_+^i + dS_i + dS_e^+ < dS_-^i + dS_e^-, \quad (10)$$

entropy decrease $dS < 0$, the system tends to order. Both differences are determined by the input negative entropy flow in open system and the internal attractive interactions in isolated system $dS_e^- + dS_-^i$.

From these formulas we researched some social sustainable developed patterns: 1) The nonlinear limit and cycle pattern of three elements; 2) the synergetic pattern on society-economy-environment developed together; 3) the promotion-restraint pattern on Five-Elements. Their basis is lower entropy, even entropy decrease. Natural laws are unfeeling, but world is not pessimistic always [11,29].

In 2023 Brent M. Haddad, Professor of Environmental Studies, University of California, and Barry D. Solomon, Professor Emeritus of Geography and Environmental Policy, Michigan Technological University, edited *Dictionary of Ecological Economics, Terms for the New Millennium* [52]. This comprehensive Dictionary brings together an extensive range of definitive terms in ecological economics, which includes the definitions of social order and social structures by author based on entropy. Assembling contributions from many scholars, it provides an intellectual map to this evolving subject ranging from the practical to the philosophical.

VI. THE DEVELOPMENT DIRECTION OF HUMAN SOCIETY

The evolution of organisms is from survival competition to coevolution. Now the biological theories also favor the important role of group selection in the evolutionary process [53]. The advantage of assembling large populations lies in maintaining population survival at the expense of few individuals. The evolution of human society must be coevolution. Its foundation is the evolution of the human heart and the human nature. Cooperation, harmony and entanglement are better than selfishness and conflict. A society, a country must be so, coevolution, common prosperity. The whole world should compete peacefully rather than wage a war.

We propose the principle of social civilization and the developing direction is: freedom of thought, rule of action. Both combinations should be a peaceful revision and improvement of social rules and laws. This is the general trend of social standardization and automation-procedural development. For example, the basis of the problem in autonomous driving must be normalization. Different countries and nations, different religions and beliefs should coexist peacefully and compete peacefully. The general public is ultimately clear about who really works for the public. Those who disobey norms should be sacrificed. Those who wage a war are guilty. Especially those war maniacs who start a nuclear war must be under sentence of death when launched. Whatever excuse they use, their purpose is simply to maintain their own power, result will sacrifice a large number of innocent people, even all humanity.

In a word, many natural-social systems can never increase entropy forever. We research many phenomena of entropy decrease in natural science. Further, some social sciences and human society are the non-equilibrium dynamic processes, which are usually accompanied by order and entropy decrease. Even in an interval they can be an isolated system.

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