Sociophysics & Sociocybernetics

An Essay on the Natural Roots & Limits of Political Control

Natura non nisi parendo vincitur. F.B.

ABSTRACT

One of the critical problems of sociocybernetics is to determine the necessity, possibility and desirability of social control by political institutions. This conundrum has been tackled repeatedly in history with various responses; some of which have been tried and failed, while others are still going on locally and temporally. Although the problems of social control is pervading and continuing, changing circumstances make all solutions parochial and ephemeral at best.

On this assumption, the question is how much further can this issue be pursued in a more general or theoretical manner. Given the complexity, extensity and intensity of contemporary social systems, can some general sociocybernetic principles be found to apply here and now, as well as everywhere and always?

It is fortunate that recent scientific discoveries give new insights to old puzzles. The latest advances of General Systems, Complexity, Quantum, and Chaos Theories emphasize the multiplicity of reality and thereby show great promise for various social applications. Combining these theories, this paper will apply the Sociophysics paradigm, which is particularly suitable here because it renders explicit the already implicit metaphors and fundamental isometries between the natural and social sciences, thus contributing to their mutual consolidation and convergence.

The central hypothesis here is that some measure of social control is necessary, possible and desirable; so the practical question becomes when, where and how it can be optimized. On the thesis that complex natural and cultural systems are difficult to know and understand, trying to manipulate them is precarious; so any attempt to control them must be thought and carried out in conformity with nature: humbly, carefully and responsibly.

Under the circumstances, human interference with fragile or chaotic systems found in both nature and culture, should be based on the principles of minimizing environmental disturbance and maximizing holistic balance. The best policy would then seem to be choosing a post-modern sociocybernetic strategy, which approaches a golden mean between the libertarian and totalitarian extremes.

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Introduction

Sociology is often considered the weakest link of the social sciences, because it lacks an adequate formal theory, which could give it a strong scientific foundation upon which to build cumulative knowledge. Since its last heyday thirty years ago, building grand social theories has fallen into lean times, but recently a new generation seems to have rekindled the fires of a general macro-synthetic trend to complement a plethora of micro-analytic establishments.

It is in this renewed neopositivist *zeitgeist* that the recent theory of sociophysics goes beyond sociobiology in contributing its **sum** (systemic unification model) to inter-scientific integration. The socioscientific paradigm rests on the tripod of rationality, sensitivity and mystery, trying to lessen the discrepancies between our inner (personal) and outer (cultural-natural) realms. It continuously confronts not only actuality but probes possibility, thereby constructing models of the world which approach but never attain an ultimate understanding.

Following a General Systems Theory perspective, our reality may be illustrated as three concentric circles: egosphere, sociosphere, and ecosphere. In this scheme, the middle ring representing society becomes our focus, whose elements are human beings and whose environment is nature. Because of the breadth of this viewpoint, we cannot here cover all aspects adequately, so we chose to concentrate on the relations between the cultural system and its natural environment. It is this physics-politics connection as studied by sociophysics that is emphasized herein.

Taking a cue from Gibbs' thesis that control is sociology's central notion, our point here will emphasize **cybernetics** as the study of governance or **control,** focusing on the intermediate regions (meso, present, social) of the above three parameters as they relate to the famous **C**^{3} (command-control-communication) triad. Wedging through all three spheres of reality, control may be studied by psychocybernetics, sociocybernetics and physiocybernetics. As social scientists, we situate the context of this concept in the cultural system and its natural environment, without forgetting its human content.

According to Freud, biology, ecology, and psychology control the human content or condition. Accordingly, human misery or malaise results from replacing natural instincts by cultural frustrations. We can rearrange these insights by sub-dividing generic self-governing, regulatory control into the following stages of hierarchical order: primary (objective physiocybernetics of inanimate matter by engineering); secondary (subjective psychocybernetics of human beings by biofeedback); tertiary (interactive sociocybernetics of group conduct by social control).

Primary control will be covered in the first chapter as the steady-state tendency of the ecosystem via existential, self-reflexive, adjusting reaction. By discovering the laws of these controls, humans can construct buildings or artifacts and manipulate or engineer their components.

Secondary control involves the innate, yet imperfect, self-control of human beings, as of all living organisms. This autonomic behavior will not be considered here, because natural evolution has deprived humans of much of their instinctive control, leaving it to intelligent, self-steering purposive action and cultural socialization to pick up the slack, as will be shown in the second chapter.

Tertiary control, which is the most important here, will be covered in the third chapter. Given the increased powers of humans over nature, but not over themselves, the only significant control remaining to be improved is in collective interpersonal relations by technical, regulative, adaptive behavior.

In correlating physics-politics-cybernetics, we form a triangular locus, which runs through our universe of discourse. These three foci are connected, thus forming an integrated system. Since control manifests itself in the interface between sociophysics and sociocybernetics via their common connecting link of physiocybernetics, the three chapters of this paper treat all these triangular relationships.

This paper can only present a two-dimensional picture of a complex reality. As the Thematic Matrix below indicates, the vertical dimension treats each of the loci between physics, politics, and cybernetics, while the horizontal dimension looks at each of the foci within the infrastructure, structure, and superstructure of our model.

Locus / Focus	Primary	Secondary	Tertiary
Physiocybernetics	Mechanics	Organics	Semantics
Sociophysics	Statics	Dynamics	Dialectics
Sociocybernetics	Macro	Micro	Meta

These two salient dimensions are based on the causal and conclusive themes, whose intersection produce the above nine combined cells. The study is thus organized in three vertical **chapters** and three horizontal **sections** of each chapter, making a total of nine sections as shown here and reflected in the Table of Contents.

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1. Physiocybernetics

1.1 Mechanics

The grand edifice of classical physics rests upon the tripod of Newtonian materialism, Cartesian rationalism and Laplacian determinism. Mass, space and time designate its three primordial physical quantities, so that almost everything else can be derived from and expressed in terms or ratios of these measures.

Simple mathematical manipulations of our innate **set** (space-existence-time) triad puts material content within a spatial field context and temporal concept, combining to produce the notions of density, motion and momentum, as well as their equivalent **conservation** laws. By combining certain natural constants and variables, physics defines the vectors of acceleration, force, impulse and pressure.

In this scheme, **force** is a central concept because it serves to produce a change of state by overcoming the natural inertia or material momentum of mass. When force is applied or a mass accelerated through space, **work** is done whose rate is measured by **power**. That is to say, power is fast work or moving force.

These Newtonian forces operating in various Cartesian fields could explain matter in motion in a perfect Laplacian deterministic causality. The realization that all matter has an inherent attribute or **charge** to influence its environment in some way by certain nuclear, electromagnetic or gravitational **fields** is fundamental to scientific relationships of local **causality**.

This idea stemmed from the search for an agent to explain change. Classical laws reduce to recursive causality. From that perception arises the desire to affect and effect change by influencing its course of action. So whether we speak of conservation or alteration of any status quo, the constants and variables of a given situation must be considered in their internal and external, structural and functional conditions.

Based on these preliminary definitions, we arrive at our central concept of **control**. Among others, one given by Gibbs gives a generic definition of control as overt human behavior by the commission or omission of an intentional act, towards a desired change in the probability of some condition. From this denotation arise a connotation implying some limitation and direction of action by a conscious agent for a certain purpose. This means that control is a state in which an act is performed according to a certain norm.

Accepting this qualitative definition, we add a quantitative one given by Young who equates control with the second derivative of velocity. This simplification and formalization means that control is the ability to alter an acceleration or the capacity to change the rate of change.

That formal definition of control implies a conscious activity which requires a legislator, interpreter, and executor, all of which amount to a governor or controller: hence cybernetics. This process operates by certain rules, within set boundaries, beyond which control is lost and chaos results. Consequently, setting standards, keeping limits, and seeking optimals, becomes the hallmark of cybernetics.

Control is very important in the exercise of power, because power becomes the ability to control the behavior of mass in space. This ability accrues to servomechanisms because they process feedbacks varying the rates of systemic change according to set values. A controller or governor is supposed to determine the state of a system at will by varying its rate of change from zero to either a positive or negative quantity within given minimax parameters. The degree, to which something can do that by obtaining and maintaining an optimal performance, indicates the amount of control it has.

Since power is directly proportional to the rate of either material accumulation, energy conversion or information flow; massive-dynamic systems require and often acquire a great deal of control in order not to self-destruct. It will become evident as we move along, that when systems become more complex, energetic and informed, they tend to get out of control unless strong cybernetic mechanisms are put in place to regulate their activities. This compulsion to control stems from the determination of systems to increase the likelihood of their survival and propagation. Unfortunately, this tendency often results in the excessive regulation and regimentation of totalitarian tyrannies, which carry a good thing too far.

1.2 Organics

Deterministic materialism however is by no means the whole story in classical physics. Mechanostatics was later supplemented by thermodynamics, when the notions of heat, energy and entropy were added to those of mass, motion and force.

In order to apply force, one needs some **energy**, thus bringing in another great concept of physics. But as energy is related to mass and velocity, it is equivalent to work. As Einstein so succinctly put it in his elegant formulation: **$E=mc^2$**, kinetic energy is matter in motion, just as potential energy is matter in position.

When we move from the macromechanical to the microchemical level, causality becomes more complicated by the addition of **random** motion. In this new condition, three statistical-probabilistic indices: heat, temperature or pressure are introduced to describe the simple and average macroscopic properties which derive from many, complex microscopic configurations.

Heat and its derivative **pressure** are created by the chance collisions of large number of bodies, so disorderly activity is a high **temperature** or excited state of chaotic motion. Because of that, although the net kinetic energy of a system may be zero, its internal potential energy or heat reflected in its temperature may be very high.

Since heat cannot be transformed into energy without some loss, the temporal symmetry of mechanics is destroyed by time's unidirectional orientation. Natural processes thus follow the path of least resistance or effort, so decreasing energy or potential becomes the **entropy** arrow of time or history.

It seems that force, energy and power abhor a vacuum, which they try to fill wherever it is found, and in doing so, spread out and loose their potency: thus increasing entropy. This process produces a macroscopic quantity that cannot be defined by the three fundamental concepts, because its dimensional content is energy divided by temperature as represented by Boltzmann's constant.

This means that in order to apply mechanical laws to large numbers (N is the number of accessible microstates), we need a constant (k) which simplifies the enormous degrees of freedom (**dof**) contained in a system. Since dof is any parameter, which can vary independently of the others, a system with a multitude of independent actors has a rather large dof.

Began as ideal gas thermodynamics, correlating pressure, volume and temperature; these statistical concepts were extended to describe **action**. In that sense, action requires the expenditure of energy or the performance of work, thus making power the dividend of energy and time.

Maupertuis law of least action captures this relationship by saying that in any change of state, the quantity of action tends to be the smallest necessary. Later, Planck discovered that if energy is carried by particles, it is proportional to the frequency of its radiation, as expressed by his constant **h**, known as a quantum of action.

Since every interaction involves an exchange of something, there is a minimal exchange threshold, measured by a quantum of interaction. Heisenberg's principle manifests the inevitable limit in measuring any activity. Accordingly, as Bohr put it, we cannot pretend to describe reality directly, but only its momentary phenomena by probabilistic rather than deterministic means.

This probabilism indicates a natural unpredictability in the dynamics of complex nonlinear systems because they are always open to unexpected innovation. This is exactly what happened with the infusion of **life** into matter. Life is that emergent property characterized by the functions of metabolic production, genetic reproduction and cybernetic reduction.

Unlike mechanostatic or thermodynamic, organic systems are **syntropic** or negentropic in that they counter and lessen entropy by building and maintaining matter, energy and order. Organisms are spatio-temporal, structural-functional, self-organizing and self-generating entities. To the primary quantities of mass, position, motion, they add qualities of feedback, cycle, and growth.

Although the syntropic process is only local and temporary for any particular living being, it evolves by alternating between genotypes and phenotypes. Gradual **evolution** tends towards symmetry-breaking, stability-perturbing and morphogeny-cascading; steps which lead to the progressive complexity-building of higher systems. Like bifurcation, evolution is a transition from a state of high symmetry, strong connectivity and low complexity to one of low symmetry, weak connectivity and high complexity. Hence, the emergence of order out of chaos and eventual life out of matter.

In this overall schema, reality appears as a series of interlocking and interacting structures whose sizes extend over forty orders of magnitude. In this wide range, there are only four universal constants: Newton's **G**, Boltzmann's **k**, Einstein's **c**, and Planck's **h**. These constants express the inherent limitations of scientific knowledge by setting the asymptotic bounds of the infinitely microcosmic (k, h) and macrocosmic (G, c) horizons. The former relate to quantum reality which delimits our temporal horizon by indicating that what is so now is not always; whereas the latter concerns general relativity which delimits our spatial horizon by indicating that what is so here is not so everywhere. Thus they force us to admit the humble truth that reality exceeds our capacity to perceive, conceive and represent it broadly, deeply, and continuously.

All this is to say that contrary to Laplacian determinism, modern physics now recognizes the limitations of stability, rationality and causality. Thus, by extension, due to our shallow logic, hollow knowledge and low energy, we must also exclude the possibility of perfect control, even in mechanic, let alone organic, systems. The all too human delusion of omnipotence, like omniscience, inevitably led to a downfall due to hubris. As two recent popular novels illustrate "Total Control" is as ephemeral as "Absolute Power" is chimeral!

1.3 Semantics

Beyond classical physics, the quantum revolution brought out the importance of information to complete our model of reality. Classical physics of objects have thus given way to quantum mechanics of subjects. Reality is now seen to be ultimately composed of facts or data, rather than objects or things.

The principles of physics must then be applied to symbols as to matter and energy. When this is done to the Law of Conservation, for instance, it means that no system can generate more than the total amount of information it already has. All it can do is manipulate and redistribute it from one level or center to another.

Shannon's formula for **information**, is the negative of Boltzmann's formula for entropy, because information decreases entropy and increases order. Entropy then becomes the lack of information or the amount of disorder in a given system. It appears not only as loss of energy, but also of information, because the symbolic content of a message is defined by the probability of its statistical entropy. Consequently, thermo-dynamic and infostatistic entropy can be made to correspond by using k as the quantum of information, which is associated with the minimal knowable dof.

Like everything else, information has a cost: every increase in knowledge is paid by an increase of entropy. The price of information however is minuscule. Thus the production of knowledge is quite economical. Nevertheless, since the higher the dof of a system, the higher its form and energy cost, chaotic complexity incurs high costs. This means that the infinite precision necessary for deterministic information is impossible because of its infinite cost; something that limits our knowledge horizon, both in time and place, making it impossible to extrapolate from here-now to always-everywhere. Whether we are dealing with Maxwell's or Laplace's demon, exact knowledge comes at a prohibitive price.

Classical physics assumes that all natural change is smooth and continuous. **Quantum** Theory has shattered that assumption by introducing many discontinuities, because there is increasing evidence that we are living in a quantum, as well as a classical, universe. The overall picture emerging from both Quantivity and Relativity is that reality is a network of relations where the traits of each part are determined by their relations to the rest, rather than by a set structure of intrinsic properties.

Moreover, the recent advances of **Chaos** Theory has given a new meaning to old concepts by recognizing a hidden order behind apparently random phenomena and emphasizing variability as the only constancy of reality. Since Poincare's complex equations a hundred years ago, chaotic dynamics have now come of age with the increasing power of computers which enable us to discover an underlying cosmos in chaos. As a result, a lot of supposed randomness stems from simple non-linear dynamic systems. So instead of trying to simplify reality to fit classic deterministic models, science can now search for the laws of complex probabilistic systems.

Reality allows such systems to be ranged along one of three conditions: a steady state of balanced uniformity, a transitory state of phase change by bifurcation or pulsation, and a random activity of chaos. Complex systems of more than three parameters or dof, can fall into any of these patterns. But ordered complexity may emerge in the middle state via a self-stabilizing cascade of symmetry-breaking bifurcations which contain intrinsically hierarchical properties.

Both holistic organicism and dialectic materialism suggest that beyond a certain level of complexity, matter exhibits emergent properties and behaviors, which do not exist and cannot be explained in terms of their lower constituents. The human **mind** and its self-consciousness are the ultimate emergent virtual property of life, whose intelligence is composed of symbolic memorization and computation, carried out by an organic hardware brain and its dedicated software mind. The triune brain represents this evolution from the reptilic (sensual), via the limbic (emotional), to the neocortic (rational) mind. Self-consciousness is thus an emergent property integrating all three.

As a result of this revolutionary development, a third source of causality may be added to determinism and randomism. This final factor --**voluntarism--** derives from human "free will" and accords some responsibility to decisions taken by people as a result of their self-controlled or intentioned acts, which are neither externally determined nor entirely random.

Nevertheless, extraordinary as it is, the human mind and its will power have severe constraints, which limit the ability to understand, let alone control complex systems. According to Godel's incompleteness theorem, no system can comprehend anything more complicated than itself. Similarly, Turing's undecidable-incomputable propositions cannot determine their truth or falsity. Thus the limits to knowledge are physical and intellectual, as well as social. Humans can only explain and control relatively simple systems; anything more is beyond our circumscribed capability.

For that reason, Ashby's Law of Requisite Variety requires that effective controls must be at least as many as the disturbances affecting a system. This means that it is possible to control adequately few and simple mechanical or physical systems; something which is done successfully by technology or engineering, because their problems are relatively easy to solve.

So far, humanity, has somehow survived and thrived, without knowing, understanding, or controlling much. As we will see next, however, because of their increasingly complex dof, controlling human or social systems, let alone understanding them, is becoming a much more difficult task, hence a highly risky and uncertain undertaking. Perhaps we have now reached, if not surpassed, the natural threshold of our innate collective competence in dealing with our cultural creations. But in case we have not, we should try to probe the limits of our capability.

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2. Sociophysics

2.1 Statics

We begin sociophysics by its simplest manifestation in Newtonian mechanics. This basic aspect of system analysis rests on the assumption of three fundamental concepts of our **set** model.

First, the material aspect of society is composed of human, artificial and natural stocks: meaning people plus their creations and possessions. Together, these aspects compose **sociomass.** Accordingly, societies have a certain mass, which can be measured by some unit of weight. Like other statistical quantities, sociomass is a useful index because it measures the gross social weight accumulating as sociosystems grow. Agricultural societies, for instance, have much less sociomass than industrial societies. Similarly, other ratios show the capital wealth of society, which varies, by rates of production and levels of industrialization.

Next, space is reflected in the **geography** or topology of a country. Social space underlies the fundamental nature of a community, which remains rather constant for long periods. Territory and location set the stage upon which human affairs are conducted, so it forms the infrastructural arena of geopolitics and macroeconomics. When sociomass is distributed over sociospace, we measure **sociodensity**. This is another useful index because it differentiates between massive or heavy urban societies, spread or sparse rural, and light nomadic hunter-gatherer ones. Obviously, sedentarization and urbanization solidifies societies into more dense and rigid states.

Finally, adding time to mass and area, introduces **history** to physiology and geography. Human action is the systemic content, which takes place in a space-time continuum and can never be isolated from its environmental context. The flow of time allows us to measure the rate of change of vital indices and add motion to position. **Sociomotion** is an index measuring the average or aggregate velocity of social components. A mobile society indicates the amount of people's travel and good's transport in sociospace. This index also measures social mobility by correlating horizontal movement in space with vertical movement between social strata.

Traditional societies are slow changing, whereas modern societies are fast moving. Social **inertia** dictates that heavy systems are slower to maneuver than light ones, hence changing the status quo of large establishments is very difficult. In this case, the Conservation of Momentum Law plays a great role in social as in all material systems. Following Newton's First Law, this conservative tendency makes all societies maintain their status quo indefinitely, unless something happens to change it.

That something is of course **force**. According to Newton's Second Law, some force, proportional to mass and acceleration, is required to change a system's state of inertia. This means that the more massive a society, the greater force we must bring to bear upon it in order to effect any social change. Without some application of force, no alteration of the status quo is possible.

Expending some energy as a result of work can only exert the required force**.** When this happens, energy is expended by bringing force to bear upon mass. So social change requires energy in order to work its way from one condition to another. No change can be made without the use of some energy in doing some work. The heavier the system, the farther and faster it is to be moved, the greater the amount of work to be done and energy to be expended.

When time is added to this equation, we get social **power**, which measures the rate of social change. In this sense, social power is the ability to make people move far and fast. The more people one can move, farther and faster, the more power one has or needs. Leaders have such power because they can get great masses do in a short time what they would not otherwise have done.

Unlike physical power, which displaces material bodies by contact or transport, social power gets human bodies to move by information and communication. Doing things by the force of verbal power is the great distinction of human society and the basic difference between brute violence and subtle influence. Power is used in both cases, but in different ways.

Energy and power are not equally spread through society. Social **structures**, and institutions accumulate and agglutinate energy in certain centers of power, while they also produce power vacuums in between. Social strata and classes are systemic hierarchies of potential power differentials, which form the classical social pyramid, where power percolates to the top.

Arrow's Paradox points to this tendency of elite control of society. Similarly, Michel's Iron Law of Oligarchy and Pareto's 20/80 Ratio of Inequality describe the general trend of power to concentrate or consolidate in small groups. In all cases, the few end up with much, while the many are left with little. Whether it is socio-masses or energies at stake, there is a definite historical tendency of unequal distribution of social goods or values in all systems. When this happens, St Mathew's Principle, Marx's aphorism and Acton's dictum come true.

2.2. Dynamics

Society, of course, is not simply a mechanical system. It also has important thermodynamic aspects depended in the transformation, distribution and utilization of energy. The macrostatistical measures of heat, temperature and pressure then apply to social as to physical systems.

Social **heat** is produced by energy conversion due to work. What kind of matter, energy and information, social systems extract, convert and distribute, how they use their natural resources and why, reveal a lot about their culture or way of life. Obviously a society animated by nuclear power will evolve a different life style than one subsisting on coal or solar energy.

Both biological and social systems share the same basic structures and functions involving an organic economy, informatic society and cybernetic polity. Like organisms, societies process matter, energy and information in order to preserve and propagate themselves in their environment. Social life exists at the edge of order and chaos, moving between one and the other, thus it needs a nutritive environment and a rich network of facilitating relationships to get up and keep going.

Like all life, society fights entropy as long as possible, by exploiting the matter and energy bounty of nature. An **economy** provides the metabolism by which societies counter entropy and maintain their collectively social as well as individually biological life. The more energy a system consumes, the more entropy it produces in its environment. The high level of human energy and ingenuity creates facts and artifacts by mental and physical work, which decrease the entropy of the social system, by increasing the natural entropy of the environment.

Social order is a state of low entropy, which requires high energy to maintain it. When such energy is not available, **socioentropy** sets in, manifested in social disintegration, disorientation and disorder. An entropic society then is a system of deteriorating levels of potential in matter, energy, and form. The natural tendency of all systems is to degenerate from high energy potentials to random waste heat, so there is a social tropism towards enervated and disorderly states, unless continuous efforts are made to maintain their structure against the ravages of time and the forces of entropy. The arrow of time decrees that all things left to themselves naturally degrade and ultimately die: from the biological life cycle of birth and death of individuals to the historical rise and fall of civilizations.

Primitive economies maintain social life very close to its naturally low levels, without too much environmental disturbances, therefore they are able to last a long time. Social development, however, like biological evolution, raises the potential energy levels of increasingly complex systems by sucking-in and using-up more and more environmental resources. Historical progress strives to climb up to higher peaks in the fitness landscape represented by improving chances for survival.

At the same time, the fitness landscape itself evolves as systems create new opportunities for their survival and progress. By doing so however, most technological advances raise metabolic activity, burning more energy and using more materials, thus shortening their life span. In contrast to millennial agricultural economies, the centennial industrial revolution increased the energy throughput of modern societies, transforming them into high temperature, thermodynamic systems.

Economic development not only increases social temperature, but also pressure, by raising expectations and demands for higher standards of living. Due to systemic inertia, however, structural changes are hard to make and slow to bring about. Periodic social **revolutions**, like natural catastrophes, clean the slate somewhat, so that the underdogs of ancient regimes can get a chance to dominate for a while in a new setting. With changing environments, what was fit under certain conditions becomes a burden in others and vice versa. But since, per definition, revolutions are very rapid and radical changes, they require a great expenditure of effort or concentrations of energy, hence they occur seldom. When they do happen, random and chaotic events, such as wars or revolutions, are very costly in human and material terms. Since it is impossible to predict and control their outcome; even when successful, it is also impossible to calculate their net cost-benefit results.

More likely, organic and social systems alike struggle to maximize fitness and flexibility by an evolutionary manner. Social Darwinism applies its combination of random variation of inherent traits and selection of the fittest adaptation for survival from biology and ecology to sociology and ideology. It thus equates social egalitarianism with communal primitivism and considers the development of social hierarchy as a *sine qua non* of evolutionary progress.

Simple Darwinism however underestimates social cooperation by emphasizing competition. Normally, organic and social systems are both cooperative and altruistic, competitive and egoistic, productive and playful, destructive and ponderous. So the Spencerian survival of the fittest does not do so only by dominating others, but also by cooperating with them and adapting to its environment.

Moreover, social evolution differs from natural evolution, in that it is more Lamarckian than Darwinian. A trait that makes social development more rapid than natural evolution, which, ironically, created human intelligence whose collective actions affect the environment so much that now are posed to accelerate the rate of natural evolution itself.

2.3 Dialectics

Societies, like organisms are centers of autonomous activity and creativity. Beyond biological and social systems in general, however, human societies are characterized by the uniqueness of their membership. Man is the paragon of animals and the highest stage of organic evolution because of introspectivity, intellectuality and intentionality. Thus human consciousness contains not only cognitive facts, but normative values, cultural symbols and proactive plans. As a result, naive reductionist and quantitative science is insufficient to explain all social dimensions. The inherent logic to social life makes it meaningful at a deeper level than merely functional incident or historical accident.

Human societies have an added and unique character which simple organic or social systems do not. Since men possess self-consciousness, our societies partake of greater creativity and complexity than other collectivities. In human societies, information and communication play a major role in shaping their form and content. Unlike instinctive behavior, intentional action is preceded by consideration, deliberation and anticipation of its consequences.

Human behavior involves a symbolic interaction between subject and object, because self-consciousness makes subjective actors interpret and impact objective reality. Men are the only self-conscious and self-steering actors with multiple and contradictory goals; consequently, as human knowledge is the result of a mind-matter dialogue, political knowledge is the result of an I-thou dialectic.

Because of their high intelligence and self-consciousness, humans can be both more cooperative and competitive than other animals. Our societies then are both more communal and conflictual than other species. Most important, we are the only **political** animals because we can solve social conflicts by dialectical means.

Social evolution converges physics and politics by softening the former and hardening the latter. This dialectic convergence from confrontation to cooperation effects a synthesis of opposites and implies that not only they are interdependent, but also capable of fusing into a single entity. For that reason, traditional philosophies stress the dialectic quality of existence, as a play between opposites: yin-yang; creation-destruction; war-peace; life-death, all of which are necessary.

Societies are complex self-organizing adaptive systems, which values creation and propagation. Since they are poised on the cosmos-chaos boundary, autopoetic systems evolve by selection and mutation, convergence and divergence. Thereby, order can emerge spontaneously by homeostatic convergence of various factors.

Between the Carlylean view of personal history made by great men and the opposite Marxian view of impersonal forces making history by deterministic processes, there is the intermediate view of combined factors operating interactively. Although historical explanations may not be directly deduced from physical laws or isolated phenomena, they can be indirectly factored from contingent chains of interdependent events. These contingencies follow from the interplay of natural, social and personal forces which are so numerous that never combine in exactly the same way, making it impossible for history to repeat itself in precisely the same way. For that reason, it is an *opera aperta*, something that makes drawing lessons from history an eclectic and dangerous occupation.

The evolution of social systems is chaotic because it is oversensitive to initial conditions. History does not repeat itself exactly because no matter how similar different cases may be, their outcomes diverge significantly. Since they are complex and open systems of near-infinite dof, societies seem to be much like quantum fields where each individual is subjected to the vector sum of forces exerted by all others.

As Poincare's premise, hundred years ago, discovered, chaotic phenomena are inherently unpredictable, because small arbitrary influences can have enormous unforeseen consequences. Thus a tiny initial mistake grows into a large final error. This peculiarity has by now been generalized by the new science of complexity, whose Mandelbrot thesis points out that since simple mathematical equations give rise to extremely complicated patterns, simple principles may underlie complex phenomena.

Human societies are perfect examples of complex systems. As such, they are more than the sum of their parts, because they possess an emergent **sociality** due to their dynamic morphogenetic field, which creates intersubjective consciousness into which individuals are socialized. Compared to animals that show a tremendous intraspecies variation in their physical appearance, humans have only slight sex, size, and color differences.

Our marked physical homogeneity, however is more than made up with our extreme cultural diversity due to differential socialization. Whereas other animals have no **culture** to speak of, humans have a plethora of **LARK** (language, art, religion, kinship) traits arising out of their different ways of thought and behavior, rather than size or shape.

Cultural traits are said to be propagated by **memes** who act like a colony of socialized viruses. Because of their similar functions, there is a profound parallelism between genes and memes. Only memes, the units of cultural inheritance, unlike genes, do not have a single archival medium of propagation but operate via linguistic communication.

The marked integrating trend of globalization contains and contradicts the memes of local traditional cultures, just as intermarriages combine genes into a common pool. Out of an increased genetic and memetic interpenetration, there is now forming a world superculture which increases human unity in both its biological and anthropological components.

Yet, rampant globalization has not yet effaced local cultures because cultural melting pots are asymptotic in their assimilating power. The more one trend acts, the more its opposite react, much like Newton's Third Law of motion. Rather than blending together, old cultures assert their differences and diverge further from one another. It seems that the more people know of each other, the more they want to retain their unique identities and accentuate their differences.

This conflict between centripetal modernization and centrifugal tradition has been going on since the dawn of urbanization and civilization. Intercultural contacts between so-called civilized and barbarian societies often resulted in conflict and violence, with the aggressor and defender roles reversing in many historical cases.
Anyway, in spite or because of their conflictual character, intercultural contacts involve and evolve progress.

Nothing new can come out of highly ordered and controlled systems. Only those at the edge of chaos, between order and disorder, can create novelty as well as court catastrophe. The prime mover of social change then seems to be the dynamic tension between interacting cultures and the resulting struggle for survival or accommodation. Isolated cultures have a predictable lifetime of rise, stagnation and fall.

On the contrary, vigorous interaction and competition bring about the necessary changes for prolonging and promoting a society, albeit with an altered culture. The alternative in any case is both intense interaction and evolution or isolation, decline and death. That is the ultimate option of dynamic systems and above all human societies. The question is to what extent it is possible or desirable to balance stability and manage change by optimal social control.

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3. Sociocybernetics

Since the publication of Ross' Social Control at the beginning of the century, sociocybernetics became the study of social normality. In a somewhat different thrust, we look at sociocybernetics as a function of three principal social sectors: economy, society, and polity. In this focus, the tasks of social control may now be classified in the domains of: impersonal impact of human activity upon natural processes and their preservation; interpersonal relations regulated by social institutions and cultural promotion; personal responsibility versus inalienable human rights and individual protection.

Accordingly, social control revolves around three essential poles: substantial (determining the transform and transport of matter and energy); behavioral (restricting human expression into socially acceptable activities); formational (regulating the flow of symbolic information and communication). On the basis of these salient points, we have to consider sociocybernetics': factual necessity (need of social control in present econoecologic circumstances); functional possibility (extent of human behavioral control within the social system); formal desirability (preference of political control over government authority).

This chapter will interpose these multiple dimensions in order to inscribe the necessity, describe the possibility and prescribe the desirability of social control for each of the above content and context in three critical sections concerning:
-Macro-unsustainability of nature by increased external human economic activity;
-Micro-ungovernability of society by increased internal cultural entropy and complexity;
-Meta-unaccountability of government by increased central technopolitical autonomy.

3.1. Macrocybernetic Factualism & Natural Realism.

The necessity of behavioral control manifests itself in many realms. Order informs living systems by bits or genes, whose information is another way of countering entropic chaos. It is the morphogenetic field generated by inherited traits and environmental influences that shapes the behavior of a system in space and time.

Potential fields naturally self-organize and generate new patterns without any preconceived plan or program. Natural selection thus operates in a random way to maintain the dynamic stability of ecosystems. Organisms, from amoebae to man, may behave randomly or independently in plentiful or pleasant conditions, but collectively or purposely under scarce, dense or critical ones. Thus emergent behavior is due more to incident fields than inherent traits.

Unless we presume God, the architecture of most natural systems, has no central governor in complete control, so a great deal of activity goes on autonomously. Overall order is then created without a central totalitarian organizer. Such naturally emergent order is much more robust, flexible and viable than that constructed arbitrarily by a central controller. In this way, natural systems have evolved under conditions unfavorable to central control.

In contrast, human systems are not natural creations but artificial constructs, so control is moot in all its sectors. As the first and primary sector of the social system, the economy provides the metabolic functions of society, thereby extracting, converting, manipulating, exchanging, and distributing raw materials and brute energies into the social system. By increasing the capacity of social metabolism, industrial economy has created serious depletion, erosion and pollution in many regions of the global ecology. Thus, as technological progress has done away with many existential problems for human life, it has created many environmental problems for wild life. While increasing human power has gradually reduced the impact of natural forces upon us, it has also increased the impact of social forces upon nature. As a result nature is now threatened by humanity, much more than humanity was ever threatened by nature.

Natural equilibria have been upset by probing and stressing their normal limits, as human economy is disturbing, if not destroying, the earth’s ecology. Widespread problems of natural resource scarcity, declining food supply, shrinking crop land, global warming, ozone depletion, unstable weather, and swelling population are interacting by positive feedbacks to overshoot Gaia’s natural carrying capacity.

Our looming environmental problems stem mainly from excessive material transforms and transfers between culture and nature, brought about by overheated industrial economies. In this case, either economic depression or dematerialization seems to be the alternatives of slowing down the throughputs between our systems and the environment. Post-industrial re-engineering has already began this process of the dematerialization and informatization of society.

But, the invisible hand of free market forces in supply and demand is not sufficient by itself to control collective economic activities, so that they can harmonize the countless contradictory individual actions. Although conservative thinking believes that such balance can eventually and inevitably be established, a considerable time lag creates great systemic instability, which must be addressed by other social means.

In this area, the natural law as the basis of social morality is now more urgent than ever before. Already, along with planetary globalization, certain uniform ethical principles are becoming widely legitimized. These new global standards are now spreading around the world as constant and universal natural law infrastructures, on the basis of which different or variable local custom superstructures may exist and flourish. Ethical relativism and cultural particularism can thereby exist on the surface, if they do not violate these deep underlying fundamental canonic human values.

In any case, whatever solutions may be considered appropriate, should be assessed and applied carefully. Since social experimentation is dangerous and difficult or risky and costly, most social evidence is open to wide differences of interpretation and confirmation. Reality cannot be grasped entirely or accurately by anybody because of the limitations of our sensory and mental apparatus, the prejudices of our ideologies and the restrictions of our language.

Moreover, social complexity makes it impossible to single out monocausality as an explanation for equifinality. These constraints impose limits to human control, due to a multitude and complexity of site and time specific factors: i.e. ecologic givens; demographic imperatives; technologic inadequacies; socioeconomic constraints.

Vying for complete control of complex systems is hopeless, as various externalities, such as incomplete information, imperfect rationality and unintended consequences, can never be completely taken into account, because it would require measuring initial conditions with infinite precision and then deducing all their effects, something impossible in practice as well as in principle. Even if each link in the causal chain could be explained, their concatenations cannot.

Taking all these things into account, we could apply Heisenberg’s uncertainty principle to politics as well as to physics. Some measure of uncertainty underlies all human thought and action. This situation faces us with a vengeance in socio-cybernetics, where the impossibility of pinpointing existential states means a loss of control and information. We must then accept these limitations are a strength, rather than weakness, because it makes us more humble, prudent and realistic.

3.2 Microcybernetic Functionalism & Moral Humanism.

Above and beyond economic infrastructures, there are cultural structures in all social systems. Culture serves consumptive and reproductive, creative and recreative, purposive and evaluative, cognitive and imaginative functions, by its familial, educational, religious, artistic and scientific institutions. These complex structures and functions obviously require some measure of control, which is not always forthcoming. When this happens, the loss of control and breakdown of order with its accompanying threat of social chaos becomes the ultimate problem of sociocybernetics.

The probability of social disorder and chaotic activity increases along with systemic potency, complexity and fragility. Powerful, sophisticated, nonlinear systems are prone to abrupt discontinuities due to random disturbances, which although could be either constructive or destructive, are nevertheless unsettling. Weighing the import of such hazards requires multiplying the probability of their occurrence by the severity of their outcome, both of which increase along with accelerating social change.

The ever present tendency of social entropy erodes social order producing anomy, atomy and alieny, primarily due to the loosening of human control over both internal passions and external actions. The socialization, which keeps behavior within certain bounds, loses its legitimacy and unleashes brutal instincts belonging to the law of the jungle. It is this degradation that sociocybernetics tries to prevent or correct, because the loss of civility eventually leads to the fall of civilization.

Technological progress has done away with a lot of existential problems, but it has also exacerbated many social issues. While increasing industrial power has gradually reduced the impact of natural forces, it has also necessitated the tightening of social controls, thus reducing people's dof of action. At the same time, the increase of social options brought about by technology and industry, has also increased choices and therefore people's dof. The individual must now constantly make economic, political and social choices, which did not exist before when either the necessity of nature or the authority of culture made them automatically.

A system that does not offer choices, does not need control. Determinism being non-cybernetic, control is a function of option. The greater the dof of the components in a system, the more control each one must exert in order to choose responsibly in relation to the others. As the increase of individual freedom releases man from traditional ties, it also compels him to bear individual responsibility for the consequences of his decisions. It thus becomes increasingly difficult to blame society for one's failures, so what seems an opportunity for the strong is a risk for the weak.

Human predilection for power and control are incentives for both liberty and tragedy. Our inquisitiveness and curiosity are great incentives for innovation and progress, but also grave dangers of getting out of control and going over the limits of viability. Now that we have been freed from many natural controls, it is incumbent upon us to replace them with either self or social-control, in order not to fall into indulgence or inertia.

Individual self-control however is constrained by the inherent limits of mental and physical capability, as well as love of adventure and mischief. Since the very idea of system implies a certain structural-functional order, any society requires some control to regulate its institutions and activities. The need for such control arises whenever the members of a group realize that they are interdependent. The higher their interdependence, the greater the need for some regulation of individual behavior for the benefit of collective coexistence. Consequently, it seems that control becomes increasingly necessary in modern societies, since they need some servomechanism to regulate behavior, lest they run amok and either implode or explode.

Yet, even if some social control may be necessary, it is not evident how to bring it about. In this quandary, two polar positions represent the ideal alternatives. On the one end, libertarianism believes that cultural, as natural, evolution can neither be stopped nor controlled. Things happen according to their own dynamic and agenda, so it is better to let them develop naturally, than try to control them inadequately. On the contrary, totalitarianism expects that social control is quite possible and desirable. At its extreme, this technocratic optimism seeks to impose controls on all social activities and thus attain perfect social order. Thus, although individuals are imperfect, the collectivity can be perfected, given strong and wise leadership.

While the first position assumes the impossibility and undesirability of social control, the second assumes its need or necessity. Reality most likely lies between these two extremes. The notorious lack of human self-control supports one side and illustrates some need of social control, but sociocybernetics also shows the difficulty, if not ungovernability of human institutions. Since humans are prone to err and sin, social policies will often be unrealistic and incorrect, so both theory and history show that perfect central control is impossible and its search is illusory.

Moreover, increasing collective social control may be undesirable because it necessarily decreases individual self-control and delimits human free will. Replacing the declining instinctive natural controls, strong mores and morals have traditionally served as cultural straightjackets, guiding social behavior within narrow channels of acceptable performance. Modern societies however have destroyed these age-old traditions, thus creating a value vacuum where trial and error are now taking place.

In the most general level, social control or governance involves institutions (rules and roles) capable of conflict resolution and collective action. Effective governance channels behavior in such way as to minimize social problems, facilitate public policy-making and maximize collective action. The rise of the third sector of civic society (associations), after the first (nation-states) and second (corporations) points to the necessity of a balanced, horizontal, flexible order in a complex world. Thus governing complexity requires a high degree of flexible organization, balancing social responsibility and individual duty.

Nevertheless, permanent social stability is neither possible nor desirable because it leads to the rigidity of sociosclerosis. Much more probable and preferable is a dynamic equilibrium, which can sustain cultural development and advance natural evolution through light and flexible control.

3.3 Metacybernetic Formalism & Practical Rationalism.

Although it is impossible to attain complete knowledge of chaotic systems, it is possible to control them somewhat. The behavior of non-linear, non-equilibrium, non-deterministic systems can be so controlled, if the controller is a conscious part of the system, as is the case of man and society. This may be done by discovering the laws of chaos which reveal a hidden higher order. In this way, some social management is feasible even in chaotic social systems.

If a modicum of social control is both necessary and possible, political institutions are the usual candidates for effecting it, since voluntary social associations and profitable economic corporations do not suffice to provide such control. Liberty and prosperity are not enough to satisfy the human will to power and control, thus we shall forever struggle to find an optimal social system somewhere, sometime.

Actually, political structures are epiphenomena of the underlying configuration of power in society, confirming that control is a function of power. The more power technology concentrates in human hands, the greater the danger of calamity or catastrophe if control is lax or lost. At the same time, the more power one has, the greater skill, nerve and foresight necessary to handle it. Powerful societies then need relatively powerful governments.

On this matter, anarchy, monarchy, and polyarchy, along with centralist and federalist models try to provide different controls to power. We cannot go here into the pros and cons of all these political options other than to say that sociophysics suggests a flexible and multiple combination where policy-making is shared among as many centers of power as possible by a constitutional regime of checks and balances.

Governance becomes much more difficult when both codes and facts or programs and data keep changing, as they do now. But since collective behavior emerges predictably out of myriad unpredictable individual acts, most of which stem from human habits and social memes, it is possible for sociocybernetics to be applied in political regulation, as in economic production and social reproduction.

For this to happen, the permanent coexistence of historical routines and unexpected routine-breaking novelties should be modeled in more sophisticated computer programs which take into account the probability of optimizing *a priori* norms against *a posteriori* facts, depending on a combination of: actor gestures; system structures; and event conjunctures.

Although human control varies from little to nil in these three categories; necessity being the mother of invention, it behooves us to probe and recognize the limits of sociocybernetics in each. Recognizing different approaches to common problems may yield equally appropriate solutions. The aim is not finding a single answer to complex questions, but a range of available options for optimal selection.

Choosing between competing options is rationalized by Bohr's Complimentarity Principle which resolves the wave-particle duality paradox by a metaphor to language, wherein we are doomed to speak words best suited to describing simple and distinct large scale objects, rather than complex and contradictory abstractions. To the simplistic and deterministic true-false dichotomy of ordinary logic, we use then add a third option of indeterminacy. Social, as quantum, logic is thus tri-valued: instead of things being either-or, they may also be both and neither.

As Bohrian probability replaces Laplacian certainty, it is evident that no model containing the complete picture of the world can possibly exist. All measurements are imprecise and uncertain, thus all knowledge must be imperfect. In social terms, complementarity explains the dual nature of man as both individualist and collectivist, egoist and altruist. These growing limits to the role of classic governance indicate that Newtonian cybernetics is superseded by chaotic cyber-technics.

Given incomplete information and imperfect rationalization, sociocybernetics must bow to the Law of Unintended Consequences, which warns of the unwanted byproducts of uncontrolled or unforeseen causes, as is often the case in chaotic systems. Since no cause can be controlled to such an extent that all its effects can be foreseen, caution must be the name of our political game. This does not always mean tepid policies. Moderation to toleration compares as modesty to mediocrity, so prudent policies need not be synonymous to pedestrian politics.

In summarizing the assessments of this chapter, we can state that as necessary as it is to impose strict controls of the social impacts on the natural environment, it is not so upon the social system itself. Similarly, it is more possible to control culture than nature; while it is most desirable to control the controllers than it is possible to do so. These differentials make sociocybernetics a difficult and diffident undertaking, not to be taken lightly or hastily.

In spite of that, sociocybernetics is as necessary as it is difficult, especially in our advanced societies entering their post-modern era; where scientism, objectivitivism, positivism, or progressivism, are no longer taken for granted, and neo-skepticism based on the ambiguity, uncertainty and absurdity of life becomes the order of the day. Our thesis then concludes that sociophysics provides the only objective standards for sociocybernetics, thus helping humanity avoid the self-contradictions which lead to excess and hubris.

Conclusion

Sociocybernetics involve a hierarchy of mechanic, organic and symbolic systems, so a temporal descriptive-explicative-predictive theory of social control must strive for a selective simplicity, combining static, dynamic and dialectic processes. Operating in all spheres of life (personal, cultural, natural); physics, politics and cybernetics combine deterministic, randomistic and voluntaristic factors to give us a systemic and systematic understanding of reality. In this respect, using an apt analogy: as successful airplane flight must abide with the laws of aerodynamics, an effective sociocybernetic exercise must abide by the laws of sociophysics.

In spite of Hume’s guillotine which does not allow normative-cognitive or is-ought metaphors, sociophysics takes a naturalist-moralist position. Like Zen, it strives to make sense of the human condition, recognizing that it may do so in vain, and transcending the absurdity of life, by living it as if it were worthwhile. Consequently, our paradigm proposes that doing what comes naturally means riding the powerful forces of nature and going along with the flow of evolution. Adapt or die is thus the primary command of nature which we ignore at our peril.

In summary, the contribution of Sociophysics to Sociocybernetics may be said to emphasize social constraint, moderate behavior, and prudent policy, reflected in three fundamental principles: Factualism: basic dependency of culture on nature (Natural Realism); Functionalism: behavioral interdependence of individuals (Moral Humanism); Formalism: checks and balances of responsible government (Practical Rationalism).

Weaving these strands together, we have arrived at some provisional theses regarding the essence of sociocybernetics in the context of nature and culture. Accordingly, social control becomes a function of human capability to influence its internal nurture, as well as external culture and nature.

The level of such control is directly proportional to cultural dynamics and its natural impacts, but inversely proportional to individual introspection and self-control. Social and personal control is thus negatively correlated, because wherever there is adequate amount of the latter, there is no need of the former. Conversely personal impotence and social irresponsibility, as is the case in large and complex societies, demands strong collective controls.

But since practical applications always lag behind ideal declarations, social control can never be complete. Although such control is increasingly necessary, it does not mean that more bureaucracy is desirable. The difficult trick is to bring about better governance (functional control) without more government (structural center).

Presently, sophisticated global computer models show the way to better data gathering and overall planning by proper accounting of the costs and risks of socioeconomic activity, thus helping governments make more enlightened decisions. As indicated here, increased knowledge in the laws of chaos should help us understand the behavior of large collectivities and thereby improve human control of its cultural and natural environment.

Social development, however, is still a long way from sophisticated centralized control. Instead, it would be more efficiently and effectively done in conjunction with socially and economically decentralized associations and corporations. Because of social complexity, chaotic causality and human incapacity, all efforts for social control must then be must be sensitive, relative and tentative.

Our syllogism then proceeds from the main premise or thesis that some control is necessary in all complex systems; it encounters the minor premise or antithesis that perfect control is impossible in reality; and finally ends with the conclusion or synthesis that a modicum of control is both feasible and desirable, or optimal and sufficient. Just as complete control is impossible and some control is inevitable; it behooves us to find the optimal conjunction in any particular place or time.

Although we are gene organisms by nature and meme machines by culture, we can rise above both by a conscious sociocybernetic control of human nurture. Even if man has an innate tendency for the sin of egoism (major premise), and condemned to a life of conflict and toil (minor premise), we can redeem ourselves by mentality and morality (conclusion).

On that argument, the hypothesis defended was that: due to systemic complexity, social control is necessary; due to scientific progress, such control is possible; and due to human imperfection, it is desirable. Having said that, we were also careful to admit that perfect control is unnecessary, impossible and undesirable. Thus we conclude that the most important and difficult task of sociocybernetics is to find the point of cyberoptimality.

In response to this challenge, we must recognize these symptoms, assess their seriousness and resolve to change our course of action by imposing some rational control on our wayward ways. The third and best way can be found between the rigid order of complete control in closed crystalline systems and the random disorder of uncontrolled anarchic chaos, in the thin edge of probabilistic dynamic, quasi-controlled, open systems. Given the great need for social control and the constraints of Bohrian complimentarity, Heisenbergian uncertainty and Godelian incapacity, sociocybernetics has a heavy task which sociophysics can enlighten. This paper was an initial attempt to do so.

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