Science and Prophecy
Humankind's Path to Peace in Global Society

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Abstract

The path to peace can be trod through rational understanding as well as through insight and intuition. The former is the way of science, the latter that of religion. In the ideal case the two paths lead to the same destination: to the next, global stage in humankind's long and complex evolution. This study explores these paths by reviewing and contrasting the understanding conveyed by the new sciences of evolution and complexity, and the insight transmitted through the revelations of the prophets of the Bahá'í Faith. Harmony between these two approaches would reinforce current attempts to raise human affairs beyond the stage of competing nation-states to that of an integrated and enduringly peaceful global society.

Résumé

Pour parvenir à la paix, on peut passer par la compréhension rationnelle aussi bien que par la perspicacité et l'intuition. Le premier chemin relève de la science; le second, de la religion. Idéalement, les deux chemins conduisent au même but, c'est-à-dire à l'étape suivante, globale, de l'évolution longue et complexe de l'humanité. Cette étude explore les deux chemins en examinant et en contrastant les connaissances acquises par les nouvelles sciences de l'évolution et de la complexité avec les connaissances transmises par les révélations des prophètes de la Foi bahá'íe. L'harmonie entre ces deux approches pourrait renforcer les efforts actuels visant à élever les affaires humaines au-delà de l'étape de compétition entre états-nations, pour en arriver à une société globale intégrée et durablement paisible.

Resumen

El camino hacia la paz puede hollarse por medio del entendimiento racional y también por la penetración personal y la intuición. El primero es la modalidad de la ciencia, y los segundos, propios de la religión. En situación ideal, ambos caminos logran la misma meta: la próxima etapa global en la larga y compleja evolución del género humano. Este análisis explora estos senderos repasando y poniendo en contraste la comprensión impartida por las nuevas ciencias de evolución y complejidad, y la penetración personal transmitida por las revelaciones de los profetas de la Fe Bahá'í. La harmonía entre estos dos enfoques reforzaría intentos actuales de elevar los asuntos humanos por encima de la etapa de naciones en competencia, a una sociedad de paz global, integrada y perdurable.

> The Bahá'í Faith . . . teaches that the fundamental purpose of religion is to promote concord and harmony, that it must go hand-in-hand with science, and that it constitutes the sole and ultimate basis of a peaceful, an ordered and progressive society.
>
> Shoghi Effendi, *Selected Writings*

The path to peace in contemporary society is not just one of the many quests of humankind but the basic and the ultimate quest. Without peace no other goals can be achieved; no other purposes can be pursued. Human survival is at stake, the continuation of the remarkable adventure in life and consciousness that is embodied in our species. The quest is of more than "local" significance: surely it matters for the entire universe, and for whatever Force, Spirit, or Intelligence is at work in its vast reaches, it matters that a species has gained knowledge of itself, and some—perhaps still rudimentary but already significant—knowledge of the nature of the cosmos, should survive and achieve a higher, more perfect understanding both of itself and of its world. In humankind the world comes to know itself, and if humankind vanishes, the world itself becomes poorer, less able to reflect the Force, the Spirit, or the Intelligence at work in its complex and harmonious processes.

The path to peace can only be trod through understanding. Peace does not come about by accident: the cards are too stacked against it in a world that is complex and full of short-sighted practices and selfish interests. Understanding, however, can be gained in different ways. One of the ways is through insight and intuition, the other through reasoning and experimentation. The former is the domain of religion, the latter of science.

The way through insight and intuition is unfettered by consideration of method and application of rules. It moves above the clouds and views the vastest vistas. Its strong point is depth and perspective; its weak point is dependence on personal wisdom. The way through reasoning and experimentation moves close to the ground; it looks only before the feet and tests the ground before placing foot on it. Its weakness is reduced horizons and the possible loss of perspective. Its advantage is the greater certitude conveyed by repeatable tests and observations.

The path to peace is through understanding, and the way of understanding takes us either through the high road of prophecy or the low road of science. But does this choice create a problem? Perhaps not. In the ideal case the two roads lead to the same destination; science and religion go hand in hand. In this ideal case the prophecy is true, and the science is valid. Together they offer perspective with insight, detailed specification with applicable information, wisdom, and knowledge. Going hand in hand, science and religion can thus be, as Shoghi Effendi wrote, "the ultimate basis of a peaceful, an ordered and a progressive society."

The notes that follow give some preliminary indications that the ideal case may indeed be the actual case, at least when it comes to prophecy by the Founders of the Bahá'í Faith and the knowledge systems emerging from some

of the new fields of the contemporary sciences. If the harmony between these spiritual and intellectual fountainheads could be demonstrated, religious faith would be bolstered by scientific knowledge, and the two together would shine brightly as the torches that light humankind's path to peace.

The method I have chosen to tackle this vast and challenging task is simple yet to the point. It is to take a passage that seems particularly relevant and meaningful from the basic writings of the Bahá'í Faith and to place it beside some of the conclusions that emerge from the study of the theories of the pertinent new sciences. Clearly, neither can I cover all passages that are particularly relevant and meaningful in the Bahá'í writings, nor can I cover all the theories and findings of the contemporary sciences. But perhaps I can demonstrate the feasibility of fulfilling the task and encourage others, more qualified than I, to bring it to completion.

> The well-being of mankind, its peace and security, are unattainable unless and until its unity is firmly established. (Bahá'u'lláh, *Gleanings* 286)

> His Cause . . . stands identified with, and revolves around, the principle of the organic unity of mankind as representing the consummation of the whole process of human evolution. (Shoghi Effendi, *Selected Writings* 1)

> The winds of despair are, alas, blowing from every direction, and the strife that divideth and afflicteth the human race is daily increasing. The signs of impending convulsions and chaos can now be discerned, inasmuch as the prevailing order appeareth to be lamentably defective. (Bahá'u'lláh, *Tablets* 171)

These citations together convey the single truth that peace and well-being are impossible without unity and that the attainment of unity takes us through despair, strife, convulsions, and chaos.

The prophetic insight is remarkable in that it perceives disunity as a prelude to, and not as a contradiction of, unity. It is remarkable also in that it views humankind's path on this planet as a process of evolution toward a mature, fully evolved condition. These insights were known to Bahá'u'lláh a century and a half ago, but they were not known to science until the last few decades. That they are now known to the followers of the Founders of the Bahá'í Faith as well as to the international scientific avant-garde gives us cause for hope as we look around us and see the "winds of despair blowing from every direction." We can now find more and more reasons to be assured that these are not winds of dissolution, decadence, and devolution, but winds that herald a new synthesis, a new creativity, a new and decisive step in evolution—a step that, in the words of Shoghi Effendi, marks the "highest stage in the stupendous evolution of man's collective life on this planet" (*World Order* 163).

But just what are the relevant findings of the new sciences? First of all, what are these "new sciences" themselves?

While science is conservative, cautious, and incremental in its "normal" state, it is bold and radical in its occasional periods of "revolution." These are times when classical theories break down, and some among many alternative theories break through. Some fields in the contemporary sciences have been in a state of revolution for the past decade or so. New theories have emerged, and previous conceptions have collapsed. Entire new fields of investigation have emerged. The most remarkable among them are those that deal with the emergence of complexity in the realms of nature and in the human world. They originated with the general system theory pioneered by Ludwig von Bertalanffy, Paul Weiss, Anatol Rapoport, and Kenneth Boulding, and with the science of cybernetics developed by Norbert Wiener, W. Ross Ashby, and Stafford Beer. Since the 1960s they were joined and reinforced by nonequilibrium thermodynamics, the work of Aharon Katchalsky, Ilya Prigogine, and their followers; by cellular automata theory pioneered by John von Neumann, and evolved in the autopoietic system theory of Humberto Maturana and Francisco Varela; and by catastrophe theory and dynamic systems theory developed by René Thom, Christopher Zeeman, Christopher Shaw, and Ralph Abraham among others.

The new sciences give us a fresh look at the world and of our place in it. They show that complexity—more precisely, complex dynamic systems such as particles, cells, atoms and molecules; cells and organisms; ecologies and societies—emerge in a constant yet discontinuous process that is creative and far from predetermined. Unlike the traditional sciences that viewed evolution as a deterministic process oriented toward equilibrium and underemphasized factors of chance and instability in favor of stability, control, and predictability, the new sciences do not formulate laws that would uniquely determine the course of evolution. The newly conceived laws state ensembles of possibilities within which evolutionary processes can unfold. As Nobel Laureate Ilya Prigogine points out, dynamic systems have a basic "divergence property." Given identical initial conditions, different sequences of events unfold—within the limits and the possibilities set by the laws. The sequences in turn create fresh sets of limits and possibilities. Thus, in the perspective of the new sciences, evolution is creative. While its past course is always logical and comprehensible, its future course is open to choice.

Freedom in evolution does not mean chaos or lack of direction. Evolution has a general direction, and also a dominant mode of progressing in that direction. The overall direction of evolution becomes evident if we compare systems that have emerged in the course of time in the universe and on Earth in regard to their size, organizational level, and bonding energy.

As a first approximation, we can distinguish three levels—more exactly, three clusters of levels—on which evolution unfolds (see figure 1). On the bottom, we have the levels of physical and chemical systems: the realm of matter. Above it, given favorable conditions, we have the levels of biological systems: the realm of life. And where the life-realm is also favorable above the biological levels, we have the cluster of organizational levels of sociocultural systems that make up the realm of society.

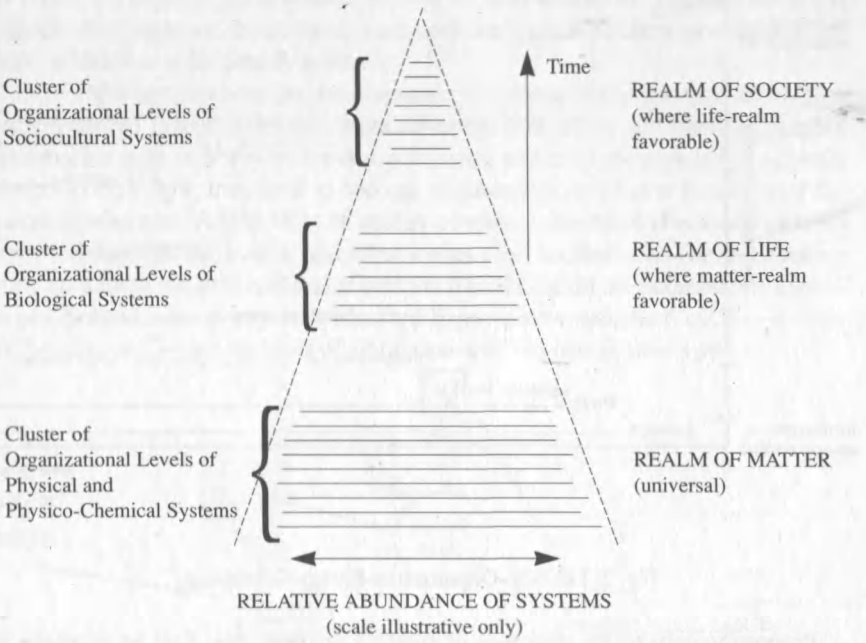

Fig. 1. The Realms of Evolution

If we line up the systems that emerge in all three of the level clusters, we may be surprised: we find a striking continuum. As we move from microscopic systems on the bottom level of organization to macroscopic systems on higher organizational levels, we move from systems that are strongly and rigidly bonded to those with weaker and more flexible binding energies. Relatively small units with strong binding forces act as building blocks in the formation of larger and less strongly bound systems on higher organizational levels. These, in turn, become building blocks in still larger, higher-level, and less strongly bonded units (see figure 2).

Particles such as the quark—whether or not any can actually be found as individual units in nature—are known to be bound together by enormously high forces. Protons and neutrons within the nucleus of atoms are bound together by nuclear exchange forces, the strength of which is strikingly demonstrated in nuclear fission. The outer shell of atoms is bound to the nucleus by electronic bonding, an entire dimension weaker than the forces of the nucleus. Atoms within complex molecules are joined by ionic or covalent bonding and related weaker forces. The forces that join chemical molecules within organic macromolecules are weaker still, while those that bond cells within multicellular organisms are another dimension down the scale of binding energy. Whatever the nature of the bonds that bind organic species and populations within ecologies and social systems, they are yet more ephemeral than physical and biochemical bonds.

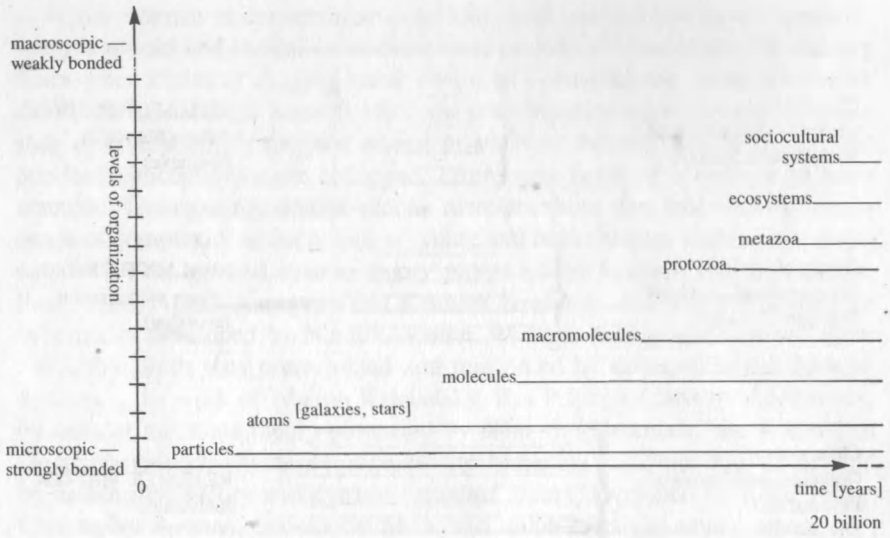

Fig. 2. The Size-Organization-Energy Continuum

Proportionately to the decrease of binding energies, we find an increase in level of organization. The concept of organizational level is understood here in the sense of a Chinese-box hierarchy of "boxes within boxes." On a given level of organization, systems on the lower level function as subsystems; on the next higher level of organization, systems jointly form suprasystems. Using this concept we can readily appreciate that the products of evolution are distributed on multiple organizational levels. Several particles jointly constitute atomic nuclei, and nuclei surrounded by electron shells form the atoms of the elements. Several atoms form simple chemical molecules, and more complex polymers are built from simpler molecules. Cells, in turn, are built from various kinds of macromolecules, organisms from cells, and ecologies and societies from populations and groups of individual organisms.

A higher level of organization offers fresh possibilities for evolution: the greater variety of components available to the higher level system allows a larger range of structural and functional variation, with new connections imposed among the richer set of component systems. Thus, by moving to a new organizational level, evolution penetrates to ever higher and more varied forms of structure and function.

The logic of evolution in regard to the formal aspect of its products is simple and elegant: it takes the most basic and strongly bound systems, exposes them to each other, and creates higher level systems based on the weaker forces that attract or repulse the more strongly bound components. Extended in time, the process begins with quarks and other elementary particles; continues with atoms, molecules, and cells; and extends, under suitable conditions, all the way

to complex organisms and their ecologies and societies. Human societies express the logic of this continuum, and the global society prophesied by Bahá'u'lláh lies at its earthly apex.

It is important to know just how systems can form on the successively higher organizational levels. Scientists have observed that when sufficiently complex components such as heavy molecules, protocells, and cells are exposed to a certain kind of energy flow, they tend to become organized to make ever more use of the incoming energies. As the flow of energy continues, the basic chemical reactions form self-maintaining cycles, and these cycles tend to interlock. The interlocking cycles maintain the structure and power the function of all the components together. As Nobel-Laureate physicist Manfred Eigen discovered, such cycles—known as "hypercycles"—are the basis of all processes of life (see figures 3 and 4).

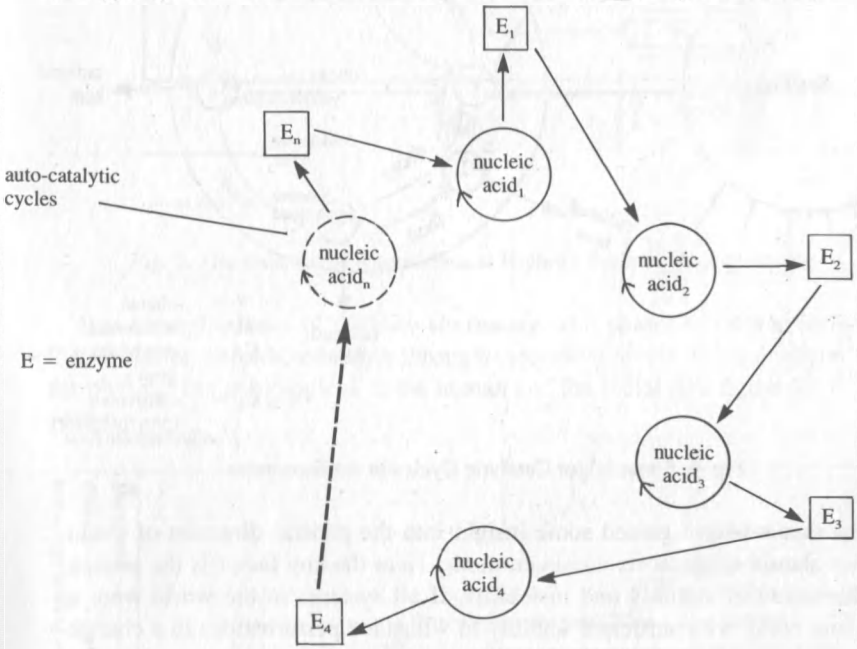

Fig. 3. A Cross-Catalytic (Hyper) Cycle

For example, nucleic acid molecules carry the information needed to reproduce themselves as well as an enzyme. The enzyme catalyzes the production of another nucleic acid molecule, which in turn reproduces itself, plus another enzyme. The loop may involve a large number of elements; ultimately it closes in on itself, forming a hypercycle remarkable for its fast reaction rates and stability under diverse parametric conditions.

The formation of hypercycles allows dynamic systems to emerge on successively higher levels of organization. Systems on one level "converge" and jointly form systems on the next. Such convergence—very different from the classical notion of convergence in political science—does not create uniformity

and sameness. It creates new systems that have unity through diversity. Evolutionary convergence is thus of the greatest relevance to the future of humankind: the global society that is the precondition of global peace would be a product of convergence among human societies through the formation of self-maintaining hypercycles on the world level.

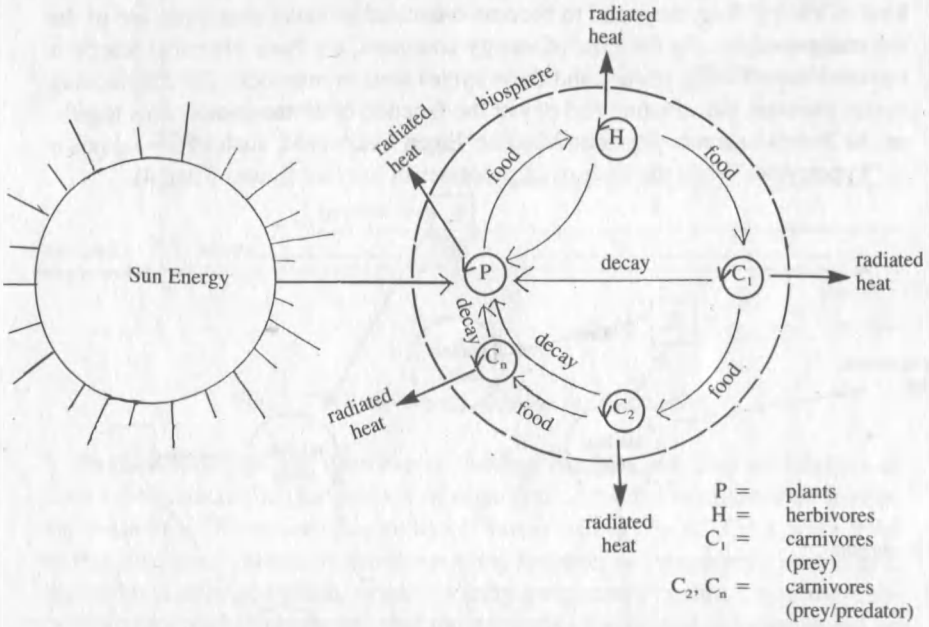

Fig. 4. Some Major Catalytic Cycles in the Biosphere

Now that we have gained some insight into the general direction of evolution, we should consider its dominant mode. Here the key factor is the sequential alternation of stability and instability. If all systems in the world were to come into being with sufficient stability to withstand perturbations in a changeable environment, the world would still be populated by hydrogen nuclei—and hardly anything else. Evolution unfolds precisely because the systems that emerge in the course of evolution are not sufficiently stable and can be seriously perturbed—in fact, critically destabilized. Experiments confirm that when critically destabilized, systems enter a transitory phase characterized by indeterminacy, randomness, and some degree of chaos. The chaotic phase comes to an end when the systems settle into a new mode of organization, possibly on a higher level of organization.

The complex systems that appear in the real world always have multiple possibilities for achieving stability. When one of their so-called steady states is fatally disturbed, other steady states can become accessible to them. The further systems are from the inert state of thermodynamic equilibrium, the more

sensitive to change is their structure and the more sophisticated are the functions that maintain it. Systems far from equilibrium can exist in many different steady states; their number grows proportionately to their complexity and to their dynamism (i.e., their distance from thermal and chemical equilibrium).

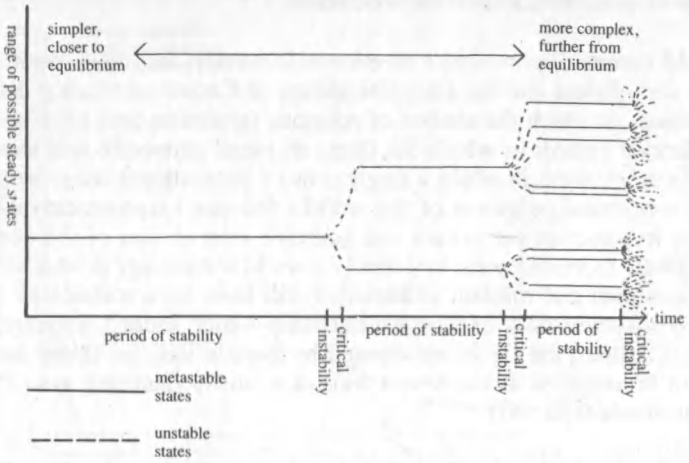

Fig. 5. The Increase of Alternatives at Higher Levels of Nonequilibrium

It is through phases of stability alternating with phases of critical instability that evolution unfolds, climbing through successive levels of organization from the physical to the biological, to the human and the social (see figure 6).

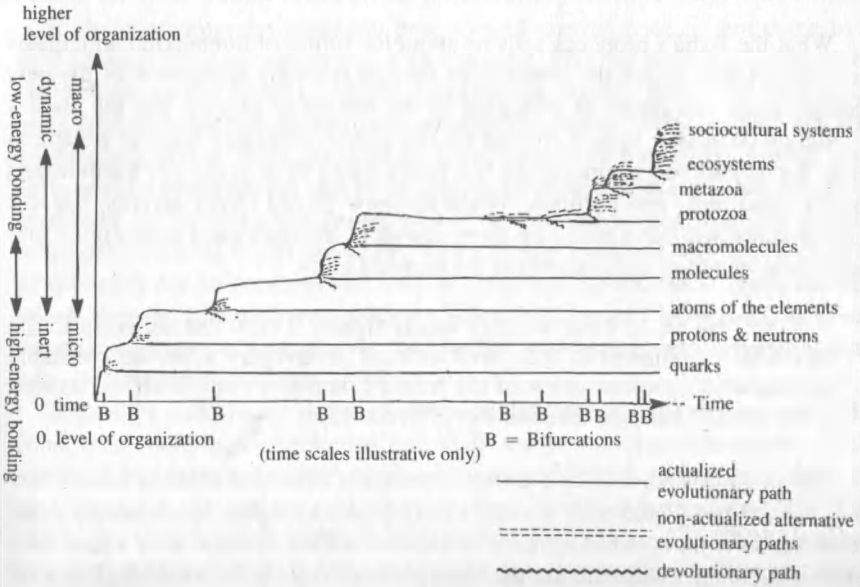

Fig. 6. The Emergence of Successive Levels of Organization through Convergence

What do these new concepts of the nature, the direction, and the mode of evolution tell us about the contemporary condition of humankind and the next step in its long and arduous evolution? They tell us much that the followers of the Bahá'í Faith already know, and much that all people, whether they believe in religion or in science, should likewise know.

> A world community in which all economic barriers will have been permanently demolished and the interdependence of Capital and Labor definitely recognized; in which the clamor of religious fanaticism and strife will have been forever stilled; in which the flame of racial animosity will have been finally extinguished; in which a single code of international law—the product of the considered judgment of the world's federated representatives—shall have as its sanction the instant and coercive intervention of the combined forces of the federated units; and finally a world community in which the fury of a capricious and militant nationalism will have been transmuted into an abiding consciousness of world citizenship—such indeed, appears, in its broadest outline, the Order anticipated by Bahá'u'lláh, an Order that shall come to be regarded as the fairest fruit of a slowly maturing age. (Shoghi Effendi, *World Order* 41)

> It calls for a wider loyalty, for a larger aspiration than any that has animated the human race. It insists upon the subordination of national impulses and interests to the imperative claims of a unified world. It repudiates excessive centralization on one hand, and disclaims all attempts at uniformity on the other. Its watchword is unity in diversity. . . . (Shoghi Effendi, *World Order* 41–42)

What the Bahá'í prophecy tells us about the future of humankind anticipates to a remarkable degree the conclusions derived from the application of the new concepts and principles of evolution to the sphere of history. For the Bahá'í prophecy outlines a system formed on the global, planetary level of organization, by hypercycles connecting the functioning of diverse yet harmonized nations, peoples, and cultures. When the new World Order arrives, today's nation-states will have given up their claims of unconditional sovereignty and acknowledged their membership in the human family.

> What else could these weighty words signify if they did not point to the inevitable curtailment of unfettered national sovereignty as an indispensable preliminary to the formation of the future Commonwealth of all the nations of the world? (Shoghi Effendi, *World Order* 40)

The step to global society signifies convergent evolution in the sphere of history to the level of the total system. Convergence to higher levels occurs in all realms of evolution. When systems in a shared milieu interact, after a time they evolve hypercycles that herald the emergence of a jointly formed higher-level system. In the case of human society, convergence has produced an entire

succession of superimposed social systems, beginning with hunting-gathering tribes, continuing through settled agrarian-pastoral societies, then through agricultural-based archaic empires and classical city-states, to the feudal and pre-industrial societies of the Middle Ages, all the way to the industrial and now post-industrial societies of the contemporary world (see figure 7).

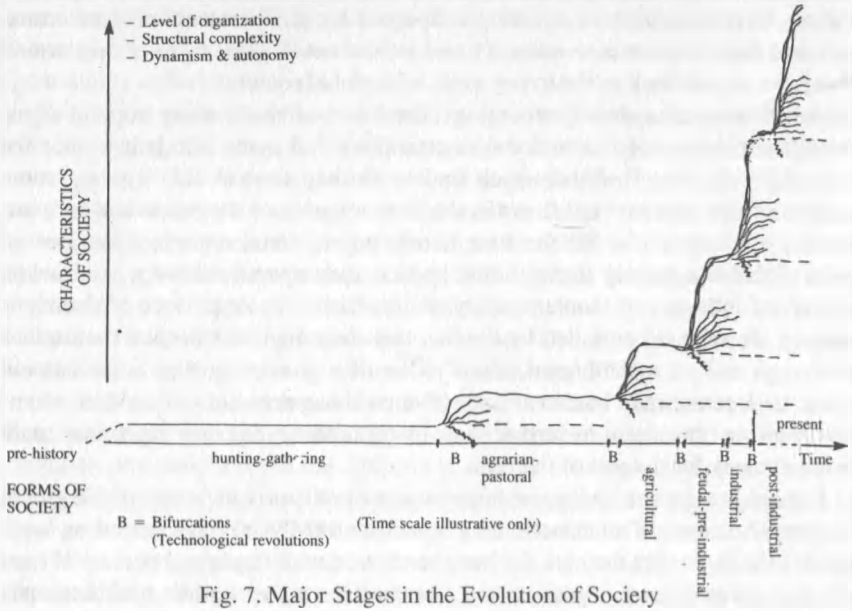

Fig. 7. Major Stages in the Evolution of Society

In the contemporary world the processes of convergence do not come to a halt, although their path is strewn with obstacles. The interactions of contemporary societies—the flows of people, information, energy, goods, and manufactures created by industrial and post-industrial societies—transcend all national boundaries. At first, these flows create interdependence but not necessarily convergence. Interdependence can be highly asymmetrical: it can embody the domination of the weak by the strong. But if the process is given time to unfold, interdependence is transformed into symmetrical relations that move beyond interdependence to convergence. Convergence among societies means that the interactions of nations have coalesced into transnational hypercycles. A transnational community emerges, formed by the interacting, interdependent, and now also integrated member nations.

In our time the many flows of people, information, capital, raw materials, food, manufactures, technologies, and skills are yet to form dependable hypercycles. Lacking transnational mechanisms of regulation and control, they are prey to selfish motivations and interests. They benefit the strong and debilitate the weak. They result in highly asymmetrical forms of interdependence and fail to create the level of integration that could assure mutual interests and mutual benefits. The World Order envisaged by Bahá'u'lláh is yet to come. In the

1990s, we live not in a peaceful global society but in conflict-torn, self-centered national states locked into global interdependence.

The winds of despair are indeed blowing from every direction. Progress seems to be blocked by the myth of the nation-state. There is, however, no cause for despair: the processes of social evolution do not stop when national governments decree themselves sovereign. Spurred by modern technologies, transnational flows continue to intensify and to interact. Sooner or later they would also have to interlock in the hypercycles of a global society.

Are these cycles already emerging? There are, after all, many hopeful signs. An entire plethora of international organizations has come into being since the end of World War II. Surely such bodies already control and regulate some aspects of the transnational flows in the joint interests of the entire human community. Unfortunately, for the time being, international organizations are not truly global but merely international bodies: they operate between, and in the perceived interests of, contemporary nation-states. Their powers of decision-making are strongly curtailed by the fact that their members declare themselves sovereign and view the organizations as fora for promoting their own national interests. International bodies are effective on those occasions when their member states can use them to further their own purposes, but they lapse into mere bureaucracies for the rest of the time.

But can we not see additional hopeful signs in the private sector of the global economy? Scores of multinational corporations (MNCs) have arisen as well, and for the most part they are far better endowed with funds and personnel than are intergovernmental organizations. Between them the world's multinationals create the great majority of the economic and financial flows that traverse the globe; it seems reasonable to expect that MNCs should also control these flows. Yet MNCs create flows where there is profit and the promise of growth for themselves, with only secondary attention to the effect of the flows on the nations and peoples where they operate—and none to those where they are not involved. MNCs are creators and operators of global flows, but they are not the guardians of human interest. They produce the global flux into which national societies are forced but do not organize them into dependable hypercycles.

Intergovernmental organizations are constitutionally constrained to serve their nation-state masters, while multinational corporations are committed to their own interests or that of their home country. They all interact with or create transnational and global flows, but none is truly effective in organizing the flows into transnational hypercycles to create a global society, capable of sustaining all people and all nations with peace and equity.

The governments of contemporary nation-states are not ready to surrender any element of their power. On the contrary, national introversion and neonationalism are on the rise. The more governments are frustrated by problems that are intractable on the national level, the more they take recourse to protectionism and to armaments to safeguard their perceived interests. The sacrosanct nature of national sovereignty is emphasized in almost all parts of the world and in all varieties of economic and political systems. In the First World of industrialized

nations, the welfare state prompts an expansion of the public sector and impedes structural adjustments that would be otherwise available to liberal free-market societies. The Second World of socialist countries, caught in the race between public expectations and the limitations of perestroika, experiences a resurgence of nationalist feeling. In the Third World national élites reinforce state structures in continued efforts at nation-building—the building of national unity, of national economy, as well as of national culture and identity—in a world that becomes increasingly unfavorable to the classical objectives of development.

Despite the noble ideals and dedicated work of international organizations and notwithstanding the many flows and interactions created by multinational corporations, today's 180 or more nation-states are major hindrances to the evolutionary process of transnational convergence. The result is the progressive loss of control by national governments, the progressive ungovernability of national societies, the exponential growth of national insecurity, and a greatly increased risk of breakdown in the now obsolete institutions of the international system. To cite Shoghi Effendi: "Nation-building has come to an end. The anarchy inherent in state sovereignty is moving towards a climax" (*World Order* 202).

A global society is coming, and with this global society will come global peace. But changes are not coming smoothly in small incremental steps. That is not how evolution proceeds; it is not the dynamic of change in complex systems. The evolution of complex dynamic systems is always discontinuous and jagged, marked by local peaks and intervening valleys. The general direction of historical evolution is not different from the general direction of evolution in nature. It climbs toward the highest-level system through sudden bursts of creativity that come in the wake of critical instabilities in the lower-level systems. Thus, the truly hopeful signs of our times are not the struggles of the present international system to achieve some form of worldwide status quo, for whatever progress is achieved is far too slow and far too inadequate to stem the tide of growing crises. Rather, the hopeful signs are the crises themselves: the progressive destabilization of today's obsolete national systems with their eternal self-interests, jealousies, narrow competitiveness, and blindness to the most elementary imperatives of human survival. For it is out of this chaos that the new order will come; it is out of the ashes of the present international disorder that the World Order of the future will arise.

For a complex dynamic system to evolve to a higher level, its destabilized and obsolescent structures must be shed and replaced by the strands of a new, wider, and more functional order. This, too, has been said:

> If long-cherished ideals and time-honored institutions, if certain social assumptions and religious formulae have ceased to promote the welfare of the generality of mankind, if they no longer minister to the needs of a continually evolving humanity, let them be swept away and relegated to the limbo of obsolescent and forgotten doctrines. (Shoghi Effendi, *World Order* 42)

It is time to relegate and time to evolve. The new combination of prophetic insight and scientific knowledge should give us direction as well as courage.

Appendix

> A mechanism of world inter-communication will be devised, embracing the whole planet, freed from national hindrances and restrictions, and functioning with marvelous swiftness and perfect regularity. (Shoghi Effendi, *World Order* 203)

Such a mechanism can, indeed, be devised. This author attempted to do so in an earlier work *A Strategy for the Future* (New York: George Braziller, 1974). The outline of the basic design is appended here to illustrate this claim; further details may be found in the above book, pp. 143–200.

Design for a World Homeostat

Vast societal processes are not the products of human engineering but can nevertheless be guided by engineered institutions. The world of phase three will not be a consciously planned world, but at best one that is consciously stabilized around states which offer the preconditions of human need-fulfillment for the world's peoples. Thus, only the regulatory element of the world will be subject to social engineering, and only this element needs to be purposively designed. The warrant for such regulation is the danger of entrusting the evolution of functional trends in the areas of security, economy, ecology, and population growth to spontaneous processes in a world which is just changing from a heady period of practically unrestricted growth to one where planetary constraints suddenly limit growth and rechannel it to new areas. This is not to presume, however, that the values of a finite world with yet unplumbed possibilities and dimensions of growth could not become sufficiently encultured to render institutional stabilization superfluous. In that happy event, centralized global guidance can be removed to the shelves of history, next to empires and sovereign nation-states.

In the meanwhile it appears unreasonable to assume that a dependable form of mutual accommodation could evolve among the world's peoples without an intervening period of institutional guidance. Such guidance presupposes a design for a universal functional regulatory organization which, somewhat tongue in cheek, we call "the World Homeostat System."

The name derives from the functional isomorphy of self-regulation in warm-blooded organisms with the required self-regulation in the world system. In both cases a regulatory capacity stabilizes inherently unstable processes around steady-states that represent the "normal" or "preferred" conditions, conducing to well-being and development. In both cases alternative means may be switched in to reduce deviations from the steady-states, and the steady-states themselves are not stationary but quasi-stationary (stationary in some respects and not in others), and are, moreover, not time-invariant but time-dependent. Cannon himself (and since then a host of social scientists and biologists) noted the analogy between self-regulation in organisms and societies; we may likewise draw on it in naming the phase-three universal regulator a World Homeostat System. But this name should not suggest that the system is either a natural or a permanent one. On the

contrary, it is proposed as a temporary instrument of conscious social engineering, to ease humankind's transition into the age of limited material growth and pronounced social and environmental interdependence.

The problem before us is to describe and define the principles by which one can design a sociocultural policy-making and -executing mechanism capable of performing the tasks associated with global homeostasis. We shall proceed by reference to general theoretical postulates first and provide operational specifications later.

The design principles of a global homeostat are the set of principles underlying the design of any control system whatsoever. These principles concern the coordination and control of functional processes in complex systems, independently of the nature of the components and the particular qualities of the system. Thus there is an isomorphy of control-system design when dealing with a house thermostat, the mechanism for keeping blood temperature constant, and with mechanisms for maintaining balance in an economy. Such isomorphy does not mean that the mechanisms themselves are interchangeable; it extends only to the basic functional relations among the components. It turns out there is a set of relationships that is more effective than any other in controlling and coordinating certain processes in systems, and this set embodies the essence of the cybernetic control mechanism regardless of the form in which it appears. The design for a World Homeostat System is isomorphic, for example, with the design for a house heating system as regards the interrelations of the main functional components. This does not mean that the World Homeostat System is "the same" in any other respect as a heating system. The particular objectives for which the control system is designed and the subtasks of its various elements must be adapted to the load of each system: keeping a house comfortably warm in winter for the house heating system, and stabilizing the world around humanly advantageous functional states for the World Homeostat System.

In this design we first outline the basic structural features of the central guidance system (these features are isomorphic with other cybernetic control systems) and then provide it with specific content in view of its global regulatory objectives.

Structure

The design we seek is that of a control system which regulates the states of another system in accordance with programmed norms. The two systems must be coupled by input and output channels of information and energy. The control system can, in principle, obtain the energies needed for its operation from outside the system it controls (as a heating system gets fuel and electricity from outside the house it heats). But control systems also exist that obtain the needed energies from within the system they control (for example, automatic pilots on planes and nervous systems in organisms). Obviously, the World Homeostat System must be able to draw all the energies, materials, and information it needs for its operation from the world system. If it does, the addition of the Homeostat System to the existing world system renders the latter

self-regulative. It provides it with a mechanism to stabilize its steady states on levels where they offer optimum conditions for satisfying human needs.

Control systems require two types of inputs: an input of physical energy (which may be in the form of fuels or substances usable by the system) and an input of *information*, which the system can "read" and use to guide its active behavior. Such systems must have at least the following components:

Sensors, for receiving information on environmental conditions that are relevant to system states;
Correlator, for storing and transforming information received from various sources;
Receptors, for receiving energy from the environment usable by the system in carrying out its operations;
Accumulator, for storing and transforming energy fed in through the receptors, and making it available to various system components for carrying out their functions;
Effectors, for carrying out operations on the environment in accordance with signals and energies received from the system.

The components are ordered along two transmission lines:

Sensors ⟶ Correlator ⟶ Effectors (the information-flow line); and

Receptors ⟶ Accumulator ⟶ Effectors (the energy-flow line).

Purposive operational capability can be introduced into the system if we add another component:

Regulator, for controlling both the information and the energy flows in accordance with programmed norms. (This requires that the regulator have information of all inputs into the control system and have access to the correlation of the inputs with the outputs.)

The *sina qua non* components and relationships can be assembled in an optimally simple design for a control system operating within a larger system. (See figure 8.)

The same components will have to be respecified, and possibly subcomponents added, if the system is to perform specific tasks. This means endowing the basic structural framework with specific content.

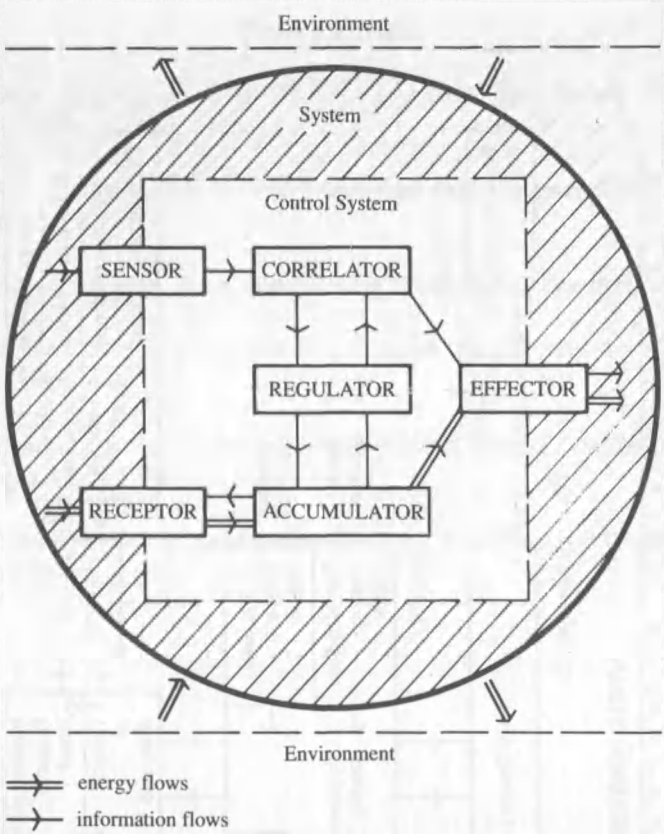

Fig. 8. A generalized model of the basic control mechanism operating within a larger system

Content

- *Definitions*. The World Homeostat System (WHS) is a central guidance system operating within the world system and regulating its functional states. The world system is the totality of the social systems of the globe together with their technologies and ecologies. It is embedded in the wider environment of the ecosphere. The ecosphere is a region of structuration superimposed on the sun-to-space energy flow on the earth's surface.

- *Objective*. The general objective of the World Homeostat System is to stabilize the world system around states which offer the optimum conditions of need-fulfillment for the entire human population. To assure this objective, the basic structural design in figure 8 is respecified to include additional components and provide specific subtasks for each. Figure 9 gives the specific design for the World Homeostat System.

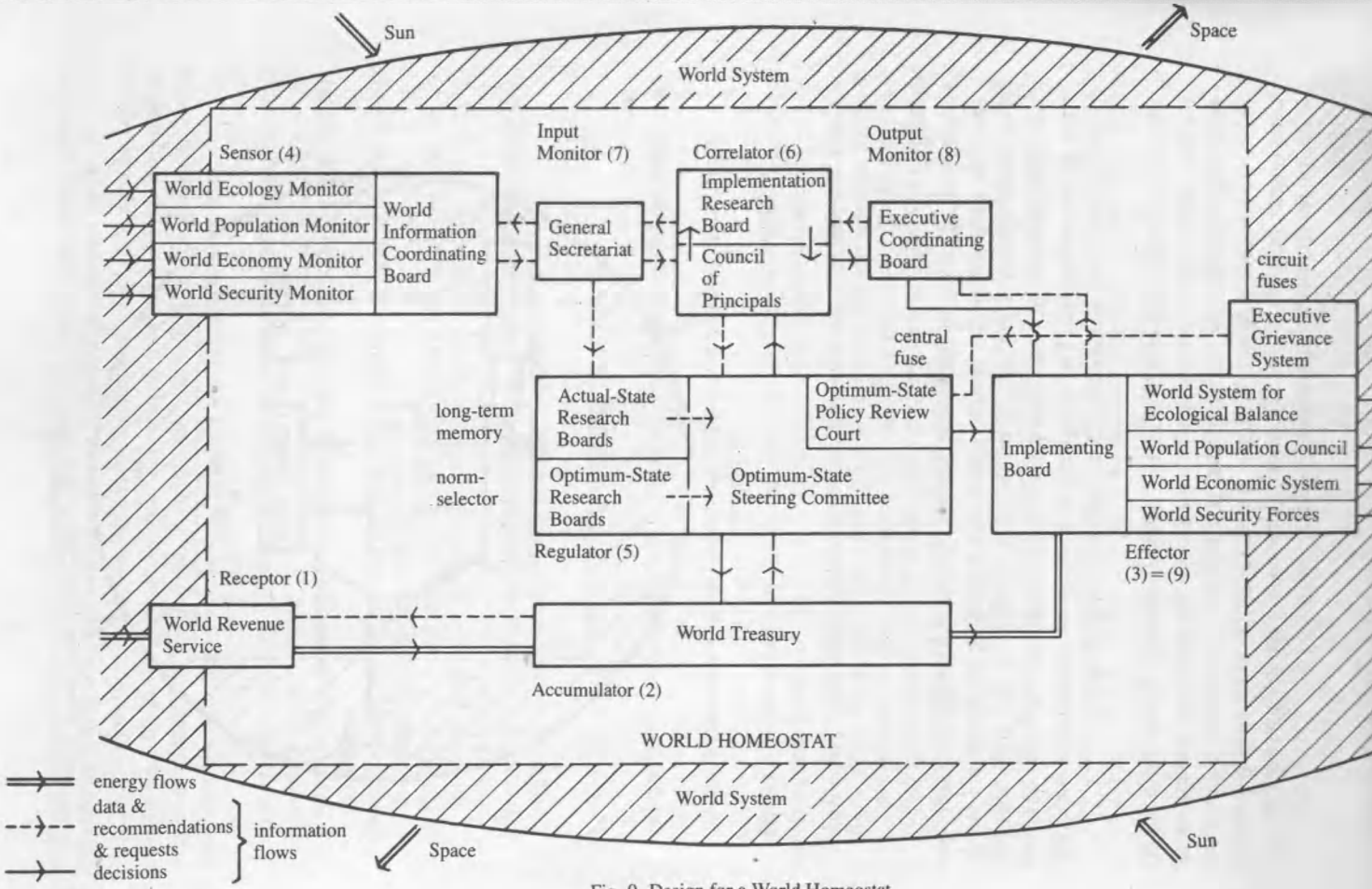

Fig. 9. Design for a World Homeostat

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