The Evolutionary Vision

Toward a Unifying Paradigm of Physical, Biological, and Sociocultural Evolution

Edited by
Erich Jantsch

AAAS Selected Symposia Series


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About the Book

"The evolutionary vision" is a term coined by economist Kenneth E. Boulding to describe a unified view of evolution that encompasses all levels of reality, from the cosmic or physical through the biological, ecological, and socio-biological to the sociocultural. It focuses less on systems or any particular entity than on the processes through which they evolve. The scientific foundations for such a sweeping view became visible in the 1970s with the emergence of a comprehensive self-organization paradigm. Concepts such as dissipative structures, synergetics, autopoiesis, hypercycles, and catastrophe theory furthered an understanding of evolution as an aspect of dissipative self-organization underlying the generation of complexity and variety at many levels.

In this volume various approaches to the self-organization of matter and information are outlined by authors who are among the chief developers of this new paradigm. They focus on the general laws governing evolutionary dynamics across all levels of evolution, including the evolution of humans and human systems. The resulting transdisciplinary view of reality emphasizes creativity over adaptation and survival, openness over determinism, and self-transcendence over security.

About the Series

The *AAAS Selected Symposia Series* was begun in 1977 to provide a means for more permanently recording and more widely disseminating some of the valuable material which is discussed at the AAAS Annual National Meetings. The volumes in this *Series* are based on symposia held at the Meetings which address topics of current and continuing significance, both within and among the sciences, and in the areas in which science and technology impact on public policy. The *Series* format is designed to provide for rapid dissemination of information, so the papers are not typeset but are reproduced directly from the camera-copy submitted by the authors. The papers are organized and edited by the symposium arrangers who then become the editors of the various volumes. Most papers published in this *Series* are original contributions which have not been previously published, although in some cases additional papers from other sources have been added by an editor to provide a more comprehensive view of a particular topic. Symposia may be reports of new research or reviews of established work, particularly work of an interdisciplinary nature, since the AAAS Annual Meetings typically embrace the full range of the sciences and their societal implications.

WILLIAM D. CAREY
Executive Officer
American Association for
the Advancement of Science

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About the Editor and Authors

Erich Jantsch *(1929-1980) completed his Ph.D. at the University of Vienna in 1951. He was at various times an astronomer, physicist, engineer, management consultant, forecaster, conservationist, general systems theorist, evolutionary theorist, humanist, and philosopher. He helped to found the Club of Rome, and he lectured at universities all over the world. His books range from works on technological forecasting to evolution, to his most recent publication,* The Self-Organizing Universe *(Pergamon, 1980). For the past ten years his center of operations was at the University of California, Berkeley. His early death has deprived the world of one of its most far-ranging and creative minds. In his own words his aims were toward "providing a perspective of hope for young people, understanding how open systems, including human systems, live and evolve, and bringing together science and the humanities in a unified view." It is an epitaph worthy of him.*

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Ilya Prigogine *is a professor at Chimie-Physique II, Université Libre de Bruxelles, Belgium, and Regental Professor*

and Director of the Ilya Prigogine Center for Studies in Statistical Mechanics at the University of Texas, Austin. He is a member of many national academies, including the U.S. National Academy of Sciences and the Academy Royale Belgique. Among his many publications are Thermodynamic Theory of Structure, Stability and Fluctuations *(with P. Glansdorff; Wiley-Interscience, 1971),* Self-Organization in Non-Equilibrium Systems: From Dissipative Structures to Order Through Fluctuations *(with G. Nicolis; Wiley-Interscience, 1977),* From Being to Becoming *(W.H. Freeman, 1980), and* La Nouvelle Alliance *(with I. Stengers; Gallimard, 1980; English edition to appear 1982, Bantam Books).*

In Memory of Erich Jantsch

Few writers have described so vividly the tragic temporal experience of man as did Jean Jacques Rousseau: time was for him the main obstacle to happiness. It seemed for a long time that Western science had exorcised time. Indeed, the basic laws of physics, be it in classical or quantum mechanics, make no distinction between future or past. The question, "What is time?" was pushed out from the frame of basic sciences to the realm of subjective experience. However, in recent decades a deep change has been taking place. We have lost confidence in external laws. Only about fifty years ago the famous French sociologist Levi-Bruhl could write, "We have a feeling of intellectual security which is so strong that we can even no more conceive how it could be shaken." But the unlikely has happened. Our intellectual security is gone. The discovery of the evolving patterns of the universe in the large, of the instability of elementary particles in the small, of a multitude of processes of self-organization on the atomic or molecular level, has indeed shattered our intellectual security. The basic laws of the world in which we are living can no longer be taken for granted.

None more than Erich Jantsch felt so intensely this bewilderment, this astonishment at the spectacle of these deep changes. However, while for Rousseau and so many others time appeared as the obstacle, the negation of reason, for Jantsch time change, evolution, became the very reason of hope, of fulfillment. At the end of the introduction to this volume, referring to the paper by Herbert Guenther, Jantsch writes:

> Instead, evolution is viewed as the expression of an "inherent playfulness of an always intelligent universe, and ... the progressive realization of this fact constitutes the greatest challenge, adventure and satisfaction of being human."

This is more than a simple verbal statement. This conviction lay at the very root of his creative life.

Shortly after the tragic death of Aharon Katzir-Katchalsky in 1972, I gave a seminar at the University of California at Berkeley. My topic was "dissipative structures" or, equivalently, self-organization through irreversible processes. Few people were interested in this subject at that time. Erich was directing a seminar for a group of students, and he sent one of them to "scout" my lecture. Shortly thereafter, I was invited to address Erich's group. It was an astonishing group. Some members were interested in shamanism, others in psychology, economics, or Buddhism. But all shared a feeling of excitement and wonder. Rightly or wrongly, Erich saw in these new developments in irreversible thermodynamics the "missing link" which would permit him to organize his immense knowledge into a single coherent whole. "The self-organization of the universe," that was to be the ambitious theme of his last book. It was much more than a mere description of facts or of more or less well-established theories. It was the expression of a deep drive towards fulfillment, the expression of a hope that our own life, part of the cosmic process, could in turn contribute to the "paradigm of self-realization through self-transcendence," to use Erich's own words. I believe that Erich's life, short as it was, has fulfilled this goal. His work has been a source of inspiration to many, young and old, who cannot avoid reflecting on the global patterns of this strange universe within which we are to live and to die.

"Evolution and Consciousness: Human Systems in Transition," was the beautiful title of a volume he edited with the late Conrad H. Waddington. There Erich wrote:

> The evolution of self-held images of man through superconscious learning provides a kind of objective, dynamic guidance for the mankind process which reached far into the future--thousands of years, or aeons....
>
> Superconscious images span aeons. This means that the image which will guide us through the imminent noetic regime is already with us.

We can only hope that such thoughts have helped him to affront the last bifurcation--which for him was only one step more towards this "imminent noetic regime" which he has described so eloquently.

Ilya Prigogine
University of Texas, Austin

Foreword

The death of Erich Jantsch has removed from the world's intellectual scene one of its most remarkable and creative minds. This volume is an appropriate memorial to him. It recreates, in many diverse aspects, the excitement which was so characteristic of his thought. Indeed, future historians of science may look back on this volume and on the meeting at the American Association for the Advancement of Science in San Francisco in January 1980 which gave rise to it, as a milestone, better, perhaps, a signpost, pointing toward a profound reconstruction in science, stretching over its whole range from particle physics to chemistry, biology, and the social sciences. This may be more than a revolution. It is more like moving into a new continent, and the name of the continent, perhaps, is "time." The science of Newton, Kepler, Dalton, LaPlace, Walras, was essentially timeless. Its principles had no history and needed none. History, indeed, was irrelevant to it. It was a science of the eternal laws of nature. Beginning, however, with Carnot and thermodynamics and going on to Darwin, Rutherford, and Bohr, irreversible time--that is, history--begins to creep into science, raising on the way all sorts of epistemological problems, many of them insoluble. Basic scientific theory, however, whether of physics or economics, remained obstinately timeless. Even today, for many people science is identified only with the experimental method, which again has little place for history.

In the light of evolutionary history, the universe looks much less like a clock wound up in the beginning and much more like a play, a play moreover in which the authors are part of the action and the script changes unpredictably all the time. The disappearance of determinism; the stress on matter and energy as deriving their evolutionary significance mainly as coders of information and even, who knows, created by it; the perception that when even quite improbable events actually happen, the history of the universe thenceforth is different;

and that equilibrium is a useful figment of the human imagination, never found in the real world, all suggest a new continent of the mind with strange intellectual flora and fauna. I am not quite sure whether we have actually landed on it, but it does seem to be much more than a bank of clouds.

This volume is not easy going. I must confess that there are parts of it where I found myself very much out of my depth. In each of these essays, however, there is the same sense of excitement. There will be legitimate criticisms. Not everyone will share Jantsch's enthusiasm for the wisdom of the East. Many of these essays suggest more than they achieve, but the feeling of adventure pervades them all, and no finer monument to a remarkable mind could be devised.

Kenneth E. Boulding
University of Colorado, Boulder

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Introduction

> How do I know the ways of all things at the Beginning?
> By what is within me.
>
> Lao Tzu, *Tao Teh Ching*

The Search for the Vision

"The evolutionary vision" is the term coined by Kenneth Boulding (1978) for the pattern connecting evolution at all levels of reality, from cosmic/physical through biological/ecological/sociobiological to psychological/sociocultural evolution. It is linked to the search for commonalities in the functioning of systems pertaining to different domains, a search most notably pursued over the past few decades by General System Theory. But its focus is not so much on systems, or any structural entity, than on the processes through which they evolve. The evolutionary vision searches for commonalities in the evolutionary dynamics at all levels of reality. It is not satisfied with a cross-section in time, but attempts to grasp the principles underlying the unfoldment over space and time of a rich variety of morphological and dynamic patterns.

The evolutionary vision tries to understand evolution as a total phenomenon, originating in the common singularity of a "big bang" (at least according to the prevalent cosmological model) and interconnected through the homology, not just the analogy, of its dynamic manifestations. In other words, evolutionary dynamics at all levels is considered as related in kind, not just in a formal way. In such a sweeping view, evolution becomes manifest in all kinds of creative dynamics, from the processes bringing about particles and atoms as well as galaxies and stars all the way to human creativity in art and science, technology and social design. A new perspective is gained thereby for an understanding of systems as the carriers, or even "power relays," of evolution.

The evolutionary vision has always been the source of profound inspiration for humanity. In Eastern mysticism and philosophy, especially in Buddhism, it has remained alive over millenia. In Western thinking, it has become temporarily subdued by an emphasis on entities (things) and by a dualistic attitude which sets part of reality absolute and excludes it from consideration. This external absolute may be a creator-god, an assumed absolute scientific Truth, or a given environment to which a noncreative Darwinian organism seeks to adapt in order to survive. As if the environment was not, at the same time, itself constituted and shaped by organisms and other forces of evolution.

Process thinking started to penetrate Western science in important ways already in the last century. Both thermodynamics and Darwin's theory of the origin of biological species introduced macroscopic irreversibility, and thus a direction of time, as well as notions such as interactive populations (of molecules or organisms) and entropy (a qualitative change in the macroscopic state of a system). New relationships between microscopic quantities and macroscopic quality emerged. The direction was set to proceed from mere change in classical dynamics to process, which is order of change, and further to evolution, which is order of process, or order of order of change, as Laszlo (1972) has pointed out.

But a scientific foundation of the evolutionary vision had to wait for the emergence of a new self-organization paradigm which constitutes perhaps the crowning scientific achievement of the 1970s, already recognizable as a great decade for science in many respects. Various approaches have been developed independently and are now turning out (not always to the joy of their discoverers) to be interrelated: Prigogine's theory of dissipative structures and principle of "order through fluctuations" (Glansdorff and Prigogine, 1971; Nicolis and Prigogine, 1977); Haken's "synergetics" (Haken, 1977); Eigen's concept of hypercycles and his theory of the origin of life (Eigen, 1971; Eigen and Schuster, 1979); Maturana's and Varela's concept of "autopoiesis" (Maturana and Varela, 1975; Varela, 1979); Thom's catastrophe theory (Thom, 1975; Zeeman, 1977); and others. The more important among these approaches are not satisfied with mere description of phenomena, but strive towards an elucidation of underlying principles and mechanisms. Some of them were even successful in predicting novel phenomena.

Through these approaches, evolution may now be understood as an integral aspect of dissipative self-organization which, in contrast to conservative self-organization which involves only static forces, uses and transforms energy (produces

entropy). In dissipative self-organization, a system is always "at work," whether it renews itself continuously in a globally stable state--exemplified by the simultaneous anabolic and catabolic reactions, the continuous building up and breaking down, of the biological cell--or whether it gives up the old structure and evolves to a new one. The focus of the present volume is, of course, on true evolution. But even in a phase of global stability and self-renewal, dissipative systems usually exhibit particular endogenous dynamics which generate rhythms making possible a certain universal communication between such systems--the "vibrations" and frequency patterns underlying our perception of reality. There is a link here to the recent "holographic" image of our relations to reality (Pribram, 1971; Bohm, 1978).

The unifying quality of the self-organization paradigm becomes apparent in the blurring of the boundary between the animate and the inanimate. If metabolism, self-reproduction and the transfer of mutations were, until recently, assumed to be unique characteristics of life, they may now be shown to hold equally for precellular systems of molecules. Chemical dissipative structures establish their autonomy from the environment and exhibit a kind of holistic "system memory." Systems act in a cognitive way with or without a brain. Evolution is not the result of one-sided adaptation and a desperate quest for survival, but--far beyond the biological realm--an expression of self-transcendence, the creative reaching out beyond the system's own boundaries.

A remarkable forerunner to a scientifically founded evolutionary vision was the book Holism in Evolution by the South African general and statesman Jan Smuts (1926). In the decades following, emphasis was placed on the development of a general theory of the ways in which systems function in their globally stable state. But in the 1970s, a series of ambitious books brought the evolutionary vision back into focus. Some of these books built explicitly on the emerging self-organization paradigm of science, others anticipated it intuitively. The following list of authors is meant to be indicative rather than complete: economists Edgar S. Dunn, Jr. (1971) and Kenneth Boulding (1978); systems philosopher Ervin Laszlo (1972); anthropologists Gregory Bateson (1972, 1979), Richard Adams (1975) and Magoroh Maruyama (1976); biologists Ernst von Weizsäcker (ed., 1974), Conrad Waddington (1975) and Rupert Riedl (1976, 1980); physical chemists Manfred Eigen (Eigen and Winkler, 1975) and Ilya Prigogine (1976; Nicolis and Prigogine, 1977); ecologist C. S. Holling (1976); geographer Alastair Taylor (1976); mathematician Ralph Abraham (1976); theoretical physicist Hermann Haken (1977); geologist Preston Cloud (1978); and an undefinable transdisciplinarian

like myself (Jantsch, 1975, 1980; Jantsch and Waddington, eds., 1976).

In my own contribution to this volume, I shall try to enumerate and discuss some of the basic principles which emerge from the evolutionary vision in the light of the self-organization paradigm. However, I wish to point here briefly to a few aspects which will have profound epistemological consequences for Western thinking. I have elaborated on them elsewhere (Jantsch, 1980).

One of these aspects concerns a basic nondualistic attitude which is more or less new in Western culture. With it, age-old dichotomies may be overcome, such as the dichotomies between nature and culture, the natural and the artificial, mind and matter, observer and observed, subjective and objective, collective and individual, and others. We, as humans, have not fallen out of evolution, but are its integral agents, the spearhead of evolution on our planet and perhaps in the entire solar system. We are evolution and we are, to the extent of our power, responsible for it. There is no guarantor in the form of an external authority. This does not imply, however, that religion is totally driven out by science; rather, science is now addressing questions traditionally reserved for religion. In a self-organizing world, evolution is non-teleological and also non-teleonomic; it is open. The emerging picture of the world becomes increasingly non-deterministic, with a new level of macroscopic indeterminacy entering with each new level of evolutionary dynamics.

Closely linked to these notions is a basic complementarity of descriptions dealing with evolutionary process. A process between self-organizing systems can never be fully described from one angle of view only. If I speak to somebody, the integral process may be fully described only by the two complementary descriptions of "speaking" and "listening." Complementarity is basic to evolutionary description in many interconnected ways. The epigenealogical (epigenetic) principle--the interaction of genotype and phenotype, or generally of conservative and dissipative principles--and the simultaneous action of chance and necessity (of stochastic and deterministic factors) are an expression of this underlying complementarity no less than the intricate interaction of macro- and microevolution, the general complementarity of matter and symbol, known and unknown (Pattee), and the linguistic complementarity of description and interpretation in the evolution of knowledge (Löfgren). "Indeed, the hidden and the manifest give birth to each other" (Lao Tzu). Linear-causal arguments have at best restricted value in process thinking. Even dialectics, the clumsy Western approach of

forcing opposites together and thereby making things move, is a far cry from true process thinking. In the latter, the opposites contain each other and need not be resolved. In the words of Chuang-Tzu, the poet-philosopher of Taoism, complementarity is at the very heart of evolution:

> Consequently: he who wants to have right without wrong,
> Order without disorder,
> Does not understand the principles
> Of heaven and earth.
> He does not know how
> Things hang together.

The evolutionary vision will also have important consequences for our understanding of the present rapid evolution of the human world. What appears as turmoil, when viewed at a microscopic level, may be the creative processes bringing about new macroscopic structures, political as well as economic, social as well as cultural. Perhaps the most profound lesson which the evolutionary vision may teach stability- and security-laden Westerners, is the attitude of nonattachment, which is held as a supreme value in Buddhism. It is entirely different from nonengagement. It means going forward gracefully "with the flow" (or, more precisely, with fluctuations), while fully engaging in the present structures as long as they hold. Nonattachment implies that there is no permanency in life--ever. The challenge is not to find security and defend stability, to accumulate goods and riches, knowledge and influence, but to become creative.

The interconnectedness of evolutionary dynamics gives rise to a new meaning of human life. We are not the highly unlikely accident as which Monod (1971) interpreted life in his strictly sequential thinking--pure chance followed by the pure necessity of survival. Instead, chance and necessity are there all the time; their complementarity is at the core of self-organization. In the self-organization paradigm, life is no longer a thin and ultimately meaningless superstructure over inanimate matter, but the natural consequence of the evolutionary thrust towards higher organization. The universe must be teeming with life, even with life matching or surpassing human intelligence. The question, "Where are they?" becomes the more tantalizing and urgent.

The ultimate importance of the evolutionary vision lies not just in its power of unifying scientific thinking and stimulating a truly transdisciplinary approach, but also in the philosophy it expresses--a philosophy close to life and its creativity. The alienation of science from life, which has become a matter of growing concern, is about to be overcome by the evolution of science itself.

Summary of Contributions

Six of the papers were presented at the 1980 AAAS Annual Meeting in San Francisco--four by their authors (Allen, Jantsch, Pattee and Boulding) and two in absentia (Haken and Prigogine). They were followed by a general discussion by Fritjof Capra. The rest of the papers had been planned for the originally envisaged full-day version of the symposium. They are included here to restore the variety and richness of thought reflected in the original program.

In this volume the contributions are grouped in such a way that they proceed from the physical to the sociocultural, from matter to symbol, from models to epistemological questions. But in the nonreductionist approach characterizing all the papers, their "starting platform" is not that important. What they try to bring into sharper focus is not a specific level of evolutionary dynamics, but the relations between a multitude of such levels. In this way a connecting pattern may be seen to emerge.

The first two papers sketch broad approaches to the dynamics of self-organization which have much in common: synergetics and the theory of dissipative structures. In his paper, "Synergetics: Is Self-Organization Governed by Universal Principles?" Hermann Haken, the originator of synergetics, provides a general introduction to self-organization in nonequilibrium systems over a wide range. He introduces the notion of order parameters which describe the dynamic modes characterizing the system at the macroscopic level. These order parameters "slave" the subsystems at the microscopic level. At critical values of external parameters, the system may become unstable and, testing new possibilities by means of internally generated fluctuations, adopt a new dynamic mode. This kind of mechanism gives rise to symmetry breaking at such instability thresholds--a general feature which may be recognized, for example, as the generation of conflict situations in economic, political or psychological contexts. The concluding list of examples of synergetic processes ranges from physics and chemistry all the way to epistemology, history and psychology.

Peter Allen is one of Prigogine's closest collaborators. In his substantial paper, "The Evolutionary Paradigm of Dissipative Structures," he first summarizes the work of the Brussels school which laid the groundwork for a theory of dissipative (i.e., entropy-producing, "working") structures. In open chemical reaction systems far from thermal equilibrium, such structures may form spontaneously as the result of interacting microscopic processes. The same self-organization