THE SYSTEMS SCIENCES IN SERVICE OF HUMANITY

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Keywords: systems science, human relations, human values, social change, societal evolution design

Contents

Summary

This article presents the systems sciences as a field of inquiry and discusses the way in which it has evolved in relation to both the theoretical and the practical concerns of

human welfare.

It begins with a brief overview and assessment of the systems sciences by considering their origins and foundations in general systems thinking. The review leads to a consideration of the ways in which it complements and contrasts disciplinary methods of human-related studies. It discusses the potential for the systems sciences to enrich descriptive, instructional, and explanatory orientations of contemporary *Geisteswissenschaften* through the inclusion of normative considerations.

The normative component of the systems sciences is considered within an evolutionary framework that presents holism as a methodology for understanding the dynamics of complex "real-world" (ontological) systems, and suggests action imperatives for their viable and sustainable design over time. Through the tools of metaphor, modeling and simulation, interactive design and other praxes, systems scientists investigate the goals and ends of systems and their interactions within environments shared with, and provided for, one another. In this way, social systems in general and human activity systems in particular can be described in function of their degree of purposefulness, in terms of the role of human values in concrete circumstances. In this sphere of the systems sciences there is a meeting place of pure and humanistic science, as the former becomes the ground for the latter. The systems sciences draw on the insights gained in both the social and the natural sciences, while both these sciences use the products and results of systems-scientific analysis and design.

Through the tools of systems thinking and design, systems science represents the world of symbols, values, social entities, and cultures as embedded in an embracing order of hierarchies that bridges the gap between C. P. Snow's "Two Cultures" of the sciences and the humanities. The use of modeling in systems sciences provides the language of design and the means by which creativity is applied in the course of inventing, making, assessing, and implementing the designs. In this way it lends to the human sciences the capability to deal with increasing systemic complexities, rapid societal changes, and design decisions that affect the sustainable evolution of human societies within the wider context of their life support systems.

1. Introduction

The role of the systems sciences in service of human welfare, and their contribution to both theoretical and practical issues of human survival in partnership with Earth, are of critical relevance to the changing nature of human relations at the dawn of the twenty-first century. Conceptual frameworks for interpreting the meaning and significance of social change run the gamut of deconstructionist post-modern interpretation, ranging from predictive/empirical to cultural/interpretative to critical/post-structural epistemological stances. In areas of human endeavor concerned with valuing and assessing human achievement, the result has been a multiplicity of possible interpretive frameworks and a concomitant fragmentation of disciplinary worldviews. While the natural sciences move toward theoretical syntheses through the construction of grand unified theories in physics and similar embracing theoretical frameworks in other realms of inquiry, the social sciences and the humanities manifest a countervailing trend toward relativistic positions on issues of societal evolution with a corresponding reticence for generally applicable normative viewpoints on designs for the future of humanity.

The advantage of the systems sciences is their potential to provide a trans-disciplinary framework for a simultaneously critical and normative exploration of the relationships between and among human beings and their social, cultural, and natural environments. Studies of civilizational progress and organizational change rely more and more on the systems approach. Systems sciences do much to render the complex dynamics of human sociocultural and politico-economic change comprehensible. Observed phenomena in the natural and human-made universe do not come in neat disciplinary packages labeled scientific, humanistic, and transcendental: they invariably involve complex combinations of fields, and the multifaceted situations to which they give rise require an integrative and holistic approach for their solution. The systems sciences provide such an approach and can consequently be considered a field of inquiry rather than a collection of specific disciplines.

2. Transformations in Society

Contemporary changes in society run deep and fast. In the last decade of the twentieth century a crucial juncture in societal evolution was reached. Societies that are growing out of the nationally based industrial systems created at the dawn of the first industrial revolution are now heading toward the interconnected and information-based global socio-economic system emerging under the impact of new technologies and new economic, social, and ecological relations. Both the ontology and the epistemology of social change require strong conceptual lenses with which to focus conceptual interpretation and effective action. The systems sciences offer such a bifocal vision.

2.1 The Subject of Societal Transformation

At the beginning of the third millennium classical assumptions concerning the nature of social and political reality have collapsed. The current system is no longer an arena for the struggle of capitalism and communism led by two superpowers; it is a more complex system with more actors and elements. The USSR has disappeared, and the US is preoccupied with economic problems at home. Japan has emerged into prominence, and the "tiger economies" of Asia are following suit. Europe has become a major economic power, with its East-West economic area of over 380 million people. Issues of environmental degradation have moved from marginal intellectual and youth groups to the center stage of international politics and global business, as some parts of the world—the 130-plus countries that make up 75% of the human race—sink rapidly into further poverty and underdevelopment.

A basic feature of the current transformation is the growing presence of information. The importance of knowledge, know-how, data, and the elaboration of data has grown exponentially in all sectors and segments of society. In the past, human communities have been shaped mainly by the information processed in individual brains; this was the case in raising children, in creating businesses, in setting up local or national governments, in organizing churches or armies, and in founding schools or theaters. But in the course of the twentieth century the information processed in human brains has been more and more supplemented by information processed in technical systems.

In the last decade of the twentieth-century, the advanced societies of the world became thoroughly “informatized”. Now they are now longer just social, socioeconomic, and sociocultural entities; they are also information-processing systems. Individuals are reaching out to electronic networks, data banks, and mainframe computers; personal computers are interconnected through a variety of networks. Thousands of complex operations are programmed into mainframe computers as algorithms, and in artificial intelligence as sophisticated heuristics. Cognitive processes are transferred to computers. The processing systems are deeply embedded in the structures of society and interact with them in countless ways.

Along with cognitive processes also *control* is transferred to computers, with the result that information processing systems acquire a high degree of autonomy. International banks and financial institutions, for example, have almost completely delegated their financial routines to computer programs interfacing with globe-circling communication networks. The information standard has replaced the gold standard as the basis for international finance; information has become the crucial factor in channeling flows of capital. Money moves almost instantly around the globe in answer to the latest information (or misinformation).
Information processing systems are integrated in manufacturing (CIM), in design (CAD), and in inventory control (JIT management). They perform essential functions for the military (early warning and remote sensing systems), in telecommunications (communication satellites), in ground and air transportation (automatic rail switching systems, auto-pilots and instrument landing systems), and in such complex operations as balancing the atomic chain reactions of nuclear power stations. The systems have become well-nigh indispensable. They can neither be substituted by human brains (it is estimated that, in Germany alone, it would take seven million persons to carry out the computational workload of the automated banking system), nor can they be “switched off“ without inducing dramatic consequences that range from stock market chaos to nuclear melt-down.

The systems are steadily climbing the ladder of human skills. Earlier devices replaced mainly lower-level skills, such as addition and subtraction, and the simpler forms of man-machine communication. With the advent of CIM and CAD, computers moved into slots that were previously the preserve of human technicians. And now sophisticated programs such as Automatic Theorem Proving (ATP) in mathematics and the automatic gene sequencers of the Human Genome Project encroach on the skills of scientific specialists.

The effects of informatization are felt beyond the industry itself: the sectoral distribution of the entire workforce is slanted toward the information area. Employment patterns have been shifting not only from agriculture toward industry, but even within industry from raw-material and energy-intensive branches toward information-intensive ones. In the US, for example, the largest single workforce in 1860 was still in agriculture; the information sector comprised but a modest 5 percent. Between 1906 and 1960 it was the industrial workforce that became dominant, peaking in 1946 with 40 percent of the total employment. In the 1950s, however, the proportion of the workforce in traditional industry began to decline, falling to 25% by the 1970s. At the same time the segment of the work force employed in the information sector began a rapid rise, reaching to about 50 percent of the total employment figure by the late 1980s. The primary and secondary information sectors taken together now account for more than 50% of the US GNP.

A new nervous system is created in society. This system is exosomatic: it operates outside the human organism and thus is not limited by the size of the cranium. It has almost infinite growth potential, with its internal bounds given only by the minimum size beyond which there is noise or cross-talk among electrons and the maximum quantity of data held by a chip. Even these limits are expandable through optical processors and holographic data storage. It is calculated that a one-inch square hologram has nearly 100 million resolvable spots available for recording. This allows some 10 000 light sources to be linked up with 10 000 light sensors, a recording magnitude well beyond the absolute physical capacity of chips. Moreover holograms, the same as chips, can be superposed to act as three-dimensional storage-media rather than as two-dimensional surfaces. In principle, a hologram the size of a cube of sugar could store the entire contents of the US Library of Congress, being capable of handling all the possible interconnections of one million optical elements—some one trillion connections.

Also the external bounds of the system are vastly expandable. Microprocessors can be associated not only with high-capacity storage media but also in communication networks of growing extension and density. The potential capacity of a global telecommunication system such as that promised through ISDN is mind-boggling. To appreciate its dimensions, we should compare it with messages transmitted by humans. A literate individual who speaks and writes a relatively large number of words each day produces in his or her lifetime a total “message unit” of approximately 650 million words. An integrated worldwide telecommunication system operating at 100 gigabits per second and relying on six space satellites could transmit one year’s total human message unit in about a month—that is, it could carry all the words spoken and written during a period of 365 days by six billion people in 30 days flat.

Another benchmark of the current transformation of society is the progressive globalization of is structures and institutions, in the public as well as in the private sector. Globalization is closely related to informatization. The exponentially growing networks of information and communication made possible the creation of international and transnational networks and associations, and many of these structures evolved into concrete business, governmental, or non-governmental organizations. The world’s global flows of information have already given birth to tens of thousands of international and intergovernmental bodies and thousands of globe-girdling business enterprises. Business enterprises and information networks were the first to reach global dimensions. Unlike governments, they were not hampered by constitutional and pragmatic ties to national constituencies and interests.

2.2 The Interpretation of Societal Transformation

Society, a dynamic but relatively simple suprabiological system, evolves in a fuzzy and generally disordered manner—so much so that students of history often question whether there is *any* pattern underlying the sequence of historical facts and events. History, as the positivists claim, seems to be “one darn thing after another”. The hypothesis that the laws governing the evolution of natural systems also govern the development of human societies is contrary to a humanistic tradition in the social sciences, but it is not intrinsically unreasonable. These laws do not prescribe the course of evolutionary development but merely set the rules of the game—the limits and the possibilities that the players themselves exploit. The ground rules for biological evolution have been set by evolution in the cosmos. For sociocultural evolution the rules have been set by biological evolution, and first and foremost by the evolution of the brain and mind of *Homo Sapiens.*

The evolutionary thesis does not mean that human societies are biologically determined. It means only that societies are evolving systems emerging and persisting within the multiple-level structure of other systems in the biosphere. Societies follow the rules set by the general laws that govern the evolution of such systems within the limits and possibilities created by human beings, their values, beliefs, habits, and mores. But societies follow these rules on their own, typically societal, level— and not on the biological level of their members.

Systems sciences perceive that there is pattern in history, as there is pattern in the evolution of order and complexity in all realms of nature. Even if the outcomes are never predetermined, it is not accidental that, given sufficient time, life should appear, and then society. It is logical, in terms of the dynamics of evolution, that on each level evolving systems should acquire greater complexity and retain more of the energy fluxes in which they are immersed. The emergence of mammals with endothermy is just as much in the logic of evolution as is the emergence of technological societies. One is a complex open *organic* system capable of storing and using increasing amounts of increasingly dense energies on the level of individual organisms and the other is a complex open *supraorganic* system with equivalent capabilities on the level of groups and populations of organisms.

The adoption of increasingly energy-intensive technologies with improved (though not necessarily optimal) efficiency sets forth the evolutionary trend toward growing dynamism and autonomy in nature. Just as organic species evolve toward the use of greater densities of a wider variety of free-energy sources in their environment, so human societies develop to access, store, and use in greater densities larger quantities of free energy through the ongoing improvement of their technologies. As a consequence societies, the same as natural systems, tend to grow larger in size, develop more intricate relations among their diverse components, and create more massive and flexible modes of interaction among them.

3. The Relevance of the Systems Sciences

The changes and transformations occurring in both science and society highlight the relevance of the systems sciences in the investigation of nature and society.

The progress of the systems sciences has been contiguous to the development of the natural sciences throughout the last century. With the Einsteinian revolution at the turn of that century, physics moved beyond the mechanistic paradigm. Then, some two decades later, with the advent of quantum theory, the physical sciences abandoned the remaining vestiges of the classical paradigm. In the life sciences, the rise of population biology and ecosystem analysis prompted a dynamic approach focused on the emerging wholes of nature, rather than on linear interactions among their parts. In some fields of the natural sciences reductionism has been completely abandoned. In quantum field physics, for example, particles are now analyzed in terms of field interactions. The fields are viewed as constituting the particles, rather than the particles constituting the fields. The distinction is significant because a continuous field is not reducible to the particles that dot its continua, much as the behavior of a dynamical system is not reducible to the equations that define relations among its individual components.

Today, the natural sciences are reaching a critical threshold. Gone is the assurance that the fundamental features of the observable universe have been already discovered; the complacency typical of the late nineteenth century all but vanished in the twentieth. Anomalies are discovered in field after field, and interest in them is growing. As the twenty-first century begins, a deepening sense of unease at the centers of the science establishment is compensated by a growing openness and sense of excitement at its innovative edge. More and more societies and associations are created for the exploration of the anomalies encountered in scientific research, and these networks are growing in prestige and legitimacy.

Thanks to the combined effort of conceptual innovators in the systems sciences, and advances in computational hardware and software, sciences such as cybernetics, general system theory, nonequilibrium thermodynamics, nonlinear dynamics, general evolution theory, evolutionary systems design, and theories of self-organization and chaos have experienced rapid development. Leading-edge scientists from von Bertalanffy to Prigogine, and from Wiener to Ashby and Abraham, learned to decode the dynamics intrinsic to complex systems without needing to decompose them to linear interactions among their elements.

However, in some human and social science fields, investigators remained wedded to the Newtonian formulas. When social scientists endeavored to emulate the natural sciences, they did not readily discover a good substitute for classical mechanics. The social entities of interest to them were thought to be reducible–ultimately—to the behaviors, values, and intentions of individual humans. These factors were taken to be related by simple and direct chains of cause and effect, so that societal interrelations, no matter how complex, could be simplified for purposes of computation.

The preferred instrument for computing interrelations was the calculus. Assuredly, the calculus functions well in regard to systems that are integrable, with causal relations among the elements conceived as linear chains of cause and effect. But the assumption of linear chains of causality could not be maintained in regard to simultaneous interactions among nonlinear processes. When a number of nonlinear cycles interact, complex loops and feedbacks are produced, exhibiting features such as recursion and self-referentiality. While at the one extreme, the behavior of the system may be so simple as to be almost linear, at the other it may be so complex as to seem chaotic. The classical calculus, adapted to the former, encouraged the assumption that societal phenomena can be analyzed into simple and linear causal relations. Recent investigations benefiting from advances in computational technology have shown the fallacy of this assumption. They have succeeded in penetrating progressively higher levels of organization, decoding dimensions of complexity that were previously thought to be chaotic. The latter, mapped by a variety of chaotic attractors, turned out to have irreducible characteristics of their own. These include a high level of input- and initial-condition dependence, fractal dimensions, and indeterminate—and thus intrinsically unpredictable—trajectories.

Systemic approaches, whether explicitly so identified or just implicitly employed, have become a mainstream methodology in the advanced branches of the natural sciences. They are most likely to gain increasing application and importance alsoin the social sciences. Notwithstanding pockets of conservatism and resistance, this expectation is justified by the fact that not only nature but also human society exhibits growing complexity. While the complexity of the former is increasing geometrically at most (due to ongoing evolution in both cosmos and in biosphere), the complexity of the latter is increasing exponentially. And, for decoding complexity, no viable alternative has presented itself in the social sciences or the humanities to the methods and models of the contemporary systems sciences. (See *System Approaches.*)

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Bibliography

Banathy B. H. (1996). *Designing Social Systems in a Changing World.* New York: Plenum Press, 372 pages. [This book covers social systems design and provides a clear synthesis of related areas of inquiry.]

Flood R. L. and Jackson M. C., eds. (1991). *Critical Systems Thinking: Directed Readings.* Chichester, UK: Wiley, 364 pages. [This book presents various aspects of recent developments in critical and emancipatory systems thinking.]

François C., ed. (1997). *International Encyclopedia of Systems and Cybernetics.* Munich, Germany: K.G. Saur, 450 pages. [This encyclopedia is an indispensable reference work for those interested in the systems sciences.]

Krippner S., Ruttenber A. J., Engelman S. R., and Granger D. L. (1985). Toward the application of general systems theory in humanistic psychology. *Systems Research* **2**(2), 105–115. [This article presents a clear exposition of the relationship between systems thinking and one area of the humanities.]

Laszlo A. (1999). Evolutionary systems design. *World Futures* **54**, 313–335. [This article introduces evolutionary systems design as a “soft technology” for the anticipatory design of evolutionary learning community.]

Laszlo A. and Krippner S. (1998). Systems theories: Their origins, foundations, and development. *Systems Theories and A Priori Aspects of Perception.* (ed. Jordan J. S.) pp.47–74. Amsterdam: Elsevier. [This chapter covers the genesis of systems theories from a theoretical and historical perspective.]

Laszlo E. (1972). *Introduction to Systems Philosophy: Toward a new paradigm of contemporary thought.* New York: Gordon and Breach Science Publishers, 328 pages. [This text book covers the development of systems philosophy.]

Laszlo E. (1975). The meaning and significance of General System Theory. *Behavioral Science* **20**(1), 9–24. [This article provides a useful introduction to the basic concepts and orientation of systems thinking.]

Laszlo, E. (1996). *Evolution: The General Theory*. Cresskill, New Jersey: Hampton Press, 208 pages. [This book introduces general evolutionary systems theory.]

Snow. C. P. (1959). *The Two Cultures and the Scientific Revolution.* New York: Cambridge University Press, 58 pages. [This classic work presents the split between the sciences and the humanities in terms of the development of separate and seemingly incommensurable scholastic traditions.]

Biographical Sketches

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Ervin Laszlo, considered the foremost exponent of systems philosophy and general evolution theory, is Founding President of the Club of Budapest, past President of the International Society for the Systems Sciences, Founder-Director of the General Evolution Research Group, Editor of *World Futures: The Journal of General Evolution* and its associated *General Evolution Studies* book series, and serves on the board of various scientific bodies and editorial committees. He has taught at Yale, Princeton, Northwestern, Houston, Portland State, and Indiana Universities, and at the State University of New York, and is currently lecturing and consulting worldwide. Ervin Laszlo is the author of more than 60 books, many of them translated into half a dozen languages, and over 300 studies and articles published in books, journals, newspapers, and magazines in many parts of America, Europe, and Asia.