The Science and Praxis of Complexity

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THE SCIENCE AND PRAXIS OF COMPLEXITY

Contributions to the Symposium Held at Montpellier, France, 9–11 May, 1984

S. Aida, P.M. Allen, H. Atlan, K.E. Boulding, G.P. Chapman, O. Costa de Beauregard, A. Danzin, J.-P. Dupuy, O. Giarini, T. Hägerstrand, C.S. Holling, M.J.L. Kirby, G.J. Klir, H. Laborit, J.-L. Le Moigne, N. Luhmann, P. Malaska, R. Margalef, E. Morin, E.W. Ploman, K.H. Pribram, I. Prigogine, Soedjatmoko, J. Voge, M. Zeleny

THE UNITED NATIONS UNIVERSITY

The United Nations University
Toho Seimei Building, 15–1 Shibuya 2-chome, Shibuya-ku, Tokyo 150, Japan
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PREFACE

The Science and Praxis of Complexity was the title chosen for an international symposium organized at Montpellier in May 1984 by the United Nations University in co-operation with the Institut pour le Développement et l'Aménagement des Télécommunications et de l'Economie and the Municipality of Montpellier.

The symposium represented the first venture of the United Nations University into this new domain of scientific endeavour concerned with the nature and behaviour of complex dynamic systems and the phenomenon of complexity. It was designed to provide a mapping of the states-of-the-art, of recent findings and approaches as they have emerged in different disciplines and areas of research. The specialists gathered at Montpellier represented a wide range of intellectual and professional expertise and interest; in addition, they had been asked to themselves choose the focus, form, and length of their written contributions. The resulting set of twenty-five papers reproduced in this volume has therefore not been subject to a common format but offers a large gamut of approaches and styles reflecting the current diversity in this new, emerging field of intellectual development.

The volume opens with a statement by the Rector of the United Nations University setting out the reasons for the interest of the University in this field. It is followed by an introduction that represents a preliminary attempt to map the area of complexity in the context of the symposium.

The main body of the volume is divided into four sections, the first of which, "Understanding Complexity," discusses various epistemological and theoretical aspects of complexity. The second section, "Complexity in Focus," comprises five accounts written by practitioners from the point of view of their specific disciplines. Section three subsequently delves into the complexity of natural systems, and section four discusses complexity in the social sciences as well as its importance in the political decision-making sphere. A last essay charts the

complexity landscape, while a set of pertinent poems written on site by one of the participants provides a poetic, final reflection on the symposium.

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OPENING STATEMENT

Soedjatmoko
Rector, United Nations University, Tokyo

It is a great pleasure to open this discussion of the science and praxis of complexity, an issue which is of singular importance to the future of the global community. Let me make it clear from the outset that I have no special competence in this field, but the United Nations University is deeply interested in the problem of complexity and the behaviour of complex systems, for our Charter enjoins us to be concerned with "pressing global problems of human survival, development and welfare." One could hardly hope to approach such an agenda without conceding first how very complex and interwoven such problems are. In today's rapidly changing, often bewildering world, complexity confronts us at every turn and at every level — from the global to the national to the local and, indeed, down to the turmoil and fragmentation that so frequently now occupy the individual human spirit.

Our essential task at the University is to try to understand better how humankind might survive in a world that is becoming increasingly interdependent and at the same time to honour indigenous values in the myriad cultures that together make up this world. What we are seeking at the United Nations University is to contribute to the search for the new instruments of governance needed to cope with a world that is in a state of unprecedented transformation.

We witness the signs of this transformation in many ways — some of them distressing, but others heartening.

The international economic system is in crisis, with rational management almost impossible. Three-quarters of a billion people are hungry in a world economy which, for all its present afflictions, still has the capacity to produce sufficient food for all. The continuing arms race is both a condition and a cause of this international economic disorder.

Our collective inability to deal with poverty and inequality has led, in some cases,

to the polarization of entire societies. Social change, resulting from economic development or its absence, has upset prevailing social and political equilibria and often has been accompanied by pervasive rural and urban violence. Where local institutions were incapable of handling such conflicts peacefully, we have seen the emergence of systems of suppression, leading to the militarization of these societies along with various manifestations of armed popular resistance.

We cannot close our eyes to the fact that since the end of the Second World War more than 130 wars have been fought in the third world and that many were due to internal instability rather than major power rivalries. We are beginning to witness in some regions of the world a situation — aggravated by the global economic recession — that may well continue into the next decade, that is, the collapse of whole economies and even states, leading to violence, civil strife, external intervention, mass exodus, annexation, and eventually the rewriting of the political geography of some of these regions. We also see migrations by millions of people across the globe into already overcrowded cities, as well as across national and even continental boundaries to the areas of affluence and the empty spaces of the world.

There are estimated to be more than 16 million refugees adrift around the globe. The migration and resettlement of refugees have already led to massive cultural and ethnic interpenetration on a global scale, severely taxing social adjustment mechanisms in many countries, North and South. These have raised political, economic, and cultural tensions that may erupt into conflicts not only along class lines but also along the fault lines of race, ethnicity, and religion.

All of this is happening in a world that has become interdependent to an unprecedented degree. Changes at the international level are now interlinked with changes at the sub-national and national levels — politically, economically, culturally, or psychologically. It is this fact that gives our explorations of the understanding and, hopefully, the management of complexity particular urgency. By bringing together evolving views on complexity, we are hoping to develop deeper insight into the problems of the management and governance of a world that is both interdependent and pluralistic.

This raises very profound questions of how to understand and attempt to manage systems that are marked by uncertainty, instability, unpredictability, and vulnerability — yet whose survival depends on their capacity for reintegration into more effective and cohesive overarching units, that have *not*, however, lost their roots.

The changes now under way are by no means wholly negative. There are many positive signs — new movements flourishing at the grass roots level and new actors taking a place on the stage of global events. In various parts of the world,

we can see the beginnings of the slow process of democratization taking place. These are still very fragile and shaky, but undeniably the hope and the aspirations are there.

These new voices from below, however, are also often disassociated from the conventional social structures — such as political parties or trade unions. There is evidence of intellectuals moving away from the universities in order to get closer to what they feel to be the new emerging forces in their societies.

The contemporary crisis in the social sciences is a reflection of our inability to deal with major societal change. The social sciences developed as a product of one particular culture. But now the social sciences, including development theory, have taken root in other cultures and they are in the process of emancipating themselves from exclusive reliance on the perceptions and intellectual orientations of the culture of origin.

An important part of this process is the shift in the role of the social scientist from observer to participant — and then from participant to activist. The disappearance of the traditional distinction between the observer and the observed not only in the social sciences but also in the natural sciences is another example of increasing complexity or, at least, a greater awareness of a dimension of complexity that poses important normative questions.

We are, therefore, involved in a major process of both mental and social restructuring due, among other factors, to the impact of science and technology, to ecological considerations, to population pressures, and to shifting values and attitudes. Value changes of many sorts — about work, life-styles, the role of the spiritual and other non-material aspects of daily life — cannot be underestimated when assessing human and social behaviour.

All of these forces for change, in one way or another, disturb prevailing equilibria that are incapable of dealing with the cumulative impact of these changes. At the national level, these processes have led to the erosion of the capacity of our political systems to deal with the changes that are occurring effectively and in a manner that is at least perceived to be legitimate. We see weak governments emerging in many parts of the world, even though power may in the same countries be increasingly concentrated within those governments. Often the degree of concentration is simply a measure of the fragility of the nature of power within the society.

The continued viability of many societies will depend in large measure on their capacity to initiate and become involved in new learning processes. We do not know what shape they will take, nor do we have the theoretical tools to design them as yet. But we have a hunch that we may be dealing here with a process that

might lead towards the enhancement of self-organization and self-management, and even possibly towards the capacity for self-directed evolution of institutions, communities, and societies.

As far as the UNU is concerned, its interest in complexity is of two kinds. One concerns the insights — with important application potential — that might be gained. The second turns around the inherent significance of the study as a major step forward in the evolution of science. In terms of the first kind of interest, it operates at two levels. The first is at a global level where interdependence and pluralism have become the main features. In the process of interdependence, we have all become more vulnerable. Our societies are permeable to decisions taken elsewhere across the world. The dynamics of interdependence might better be understood if we think of the globe not in terms of a map of nations but as a meteorological map — where weather systems swirl independently of any national boundaries and low and high fronts create new climatic conditions far ahead of them.

However, while the homeostatic capacity within certain time limits of such a system has held so far, it is confronted by the greater political consciousness of people. There are many more actors than there are states — actors at the sub-national, national, and international levels. At the same time, there has been a tremendous expansion of the power of human beings, even to the point where it could destroy civilization as we know it. It is the process of global transformation combined with this destructive capacity that amounts to a veritable mutation of the human condition — and we are going to have to learn to live with it if we are to survive.

Already we are in a situation where no single government or group of governments can control the world and the historical process now under way — nor is it likely that we will move to a situation of a new hegemony of the very few. The problem, therefore, is: How do we learn to manage effectively a system in which no single power is in control?

Such management will have to extend itself to the economic, financial, ecological, and population fields, and those realms we call the global commons: our seas, our air, and the reaches of outer space.

All of these areas need new instruments of governance that we do not currently possess. To attain such instruments, we need first to improve our understanding of the phenomenon and level of complexity that human society has now attained. It is for this reason that we at the UNU are looking for insights on complexity which you may offer us. These explorations will have to differ sharply from the classical method of reduction and simplification of problems. We need intellectual, conceptual tools that will admit complexity, include paradox and contradiction,

and move beyond static models of complex systems to include the dynamic instability inherent in complexity.

The second level at which the UNU has become interested in complexity is in the development field. It has become quite clear that the complexities connected with very rapid and profound social and cultural change, which are part of development, pose new challenges to governance. The technocratic solutions worked out by the so-called experts leave much to be desired. It is really no contribution at all, in this crucial period, to arrive at a brilliant technical and institutional formulation that has no realistic possibility of implementation. The forging of political will, social adaptability, and popular acceptance must be an inherent part of the formulation of initiatives, not a precondition or an afterthought.

It is becoming increasingly clear that among the crucial elements of the development process one has to count the views and voices of the so-called marginalized people. Ultimately, many of the decisions on which the future of developing societies as well as that of the whole human community depends — in an economic, social, and ecological sense — are made by the small farmer, the landless, and the poor. It is they who will determine to a very large extent the shape and the nature of the societies that are evolving. Here, again, one needs to emphasize the importance of a social learning process that must be set in action.

This raises another very important dimension of the development process, both locally and globally: how to reconcile the need for self-management and freedom on the one hand with the need for the most rational allocation of resources at the national and international level on the other. No developing country yet has successfully demonstrated the ability to deal with these seemingly conflicting demands. Freedom always seems to lose out — whether the development process is rapid and successful or non-existent. I, personally, have long been searching for a theory of democratic development — and thus far have failed. Such a theory will obviously be very complex. My hope is that it may emerge from a pulling together of different insights on complexity such as we are groping for at this meeting.

Futuristic scenarios remain silent on the question of freedom — the implicit assumptions seem to be that the management of the global interdependent system will ultimately have to be authoritarian. This is, to me, unacceptable. Therefore, the key question that must be asked is: Can there be a scenario of freedom in our responses to the complexity of problems on a global scale? For to sacrifice freedom for development is self-defeating in the most literal sense.

Complexity cannot be managed, intellectually or practically, through increased control. We will have to learn to understand and manage complex systems while respecting the autonomy of the processes and the elements within these systems.

We will have to rethink our attitudes towards order and disorder, and accept that disorder is not only negative but also a precondition for the creation of new orders. We need to consider the levels of disorder that we can accommodate in a humane manner, without recourse to oppression and violence. And for this task we need to draw upon the insights of all cultures. Complexity has been confronted in different ways in various non-Western cultures. Some, for example, have an extraordinarily developed facility for pattern recognition. I would very much hope this project in the next phase will be able to explore, together with those of you who are interested, these other, non-Western approaches to complexity.

At the UNU, we thus have two essential reasons for our interest in the study of the science and praxis of complexity. First, for the utility of the insights that such a study might bring to the crucial question of how to understand and manage a pluralistic global system in the process of rapid transformation in ways that are humane and respectful of the autonomy of a human being. Second, we are interested because of the inherent value of the study of complexity in a world that must daily accept what Edgar Morin has called "the complex tissue of reality." The rage for order, expressed in simplification and reductionism, has been a classic pathway to knowledge. But, now, many fields of expertise — the brain sciences, urban management, physics, geography, and economics, to cite a few of those represented here — are recognizing that they must confront the problem of complexity. An additional factor here, of course, is that the acts of observation, explanation, and interpretation become elements in the phenomenon being observed. But it should be recognized that the acceptance of new paradigms of reality by a growing number of disciplines constitutes a watershed in scientific enterprise — one from which it may be possible to open up vast new theoretical spaces and a far greater capacity to reason with the uncertainties and instabilities of our present-day world. We at the United Nations University are very enthusiastic and very excited about being part of this new venture in enlarging the vision of humankind.

INTRODUCTION

Edward W. Ploman
Vice-Rector, Global Learning Division, United Nations University, Tokyo

The choice of complexity as the focus for the Montpellier symposium represented a calculated risk. Complexity itself is a somewhat daunting, admittedly exciting — and complex subject. The following introductory remarks, therefore, represent an attempt by a non-specialist — before, during, and after the Montpellier symposium — to clarify his own understanding through a preliminary and summary mapping of concepts and trends, of prevailing winds of influence in what appears as a novel and innovative area of scientific endeavour.

Reflections on the Montpellier Symposium

In trying to approach new trends and approaches at the frontiers of knowledge, why choose complexity as the key concept? There would seem to be many choices among currently emerging concepts such as self-organization or autopoiesis, dissipative structures, order and disorder, and new variations of evolutionary or information theory. However, complexity seemed better to capture what appears as consistent preoccupations in relevant fields of work. This concept also points to a linkage between science and praxis: one can consider the management of complexity but not of a theory. Thus, in what follows, "complexity" will be used as a shorthand expression for new perceptions and representations of reality, for new scientific approaches and paradigms resulting from the study of complex systems, natural or social, in diverse fields of pure and applied science.

Research and reflection in both classical and new disciplines contribute to the emergence of what appears as a new "science of complexity." Relevant findings and ideas are to be found in such classical disciplines as physics, chemistry, biology, and mathematics as well as in more recent branches of knowledge such as general systems theory, information and computer science, telecommunications theory, and ecology and environmental sciences or in the development of new

approaches in areas such as geography, urban studies, economics, neurophysiology, and the cognitive sciences.

Even though the basic relevant scientific work seems unassailable when measured in terms of Nobel Prizes and other recognition, it would have been surprising if the implications and extensions of this work had already gained general adherence, or had not been subject to sometimes fierce criticism. From one perspective, the current situation can be described in terms of Thomas Kuhn's structure of scientific revolutions, in which a dominant paradigm, or rather, a set of paradigms, is being questioned and proven inadequate or otherwise unsatisfactory. Other analysts speak of a "mutation of knowledge," still others of a general crisis in thinking, representation, and discourse, and even in perception.

There is, then, as could be expected, a diversity of views on how far and how deep this scientific "revolution" really goes. It seems, though, that whatever the differences in background and approach among participants at Montpellier and among other scholars working in the field, there is an implicit or explicit concurrence on one basic point: the present situation of moves towards a new dialogue between man and nature, and insights into new possibilities of describing and understanding nature and society is unique. Advanced experimental, empirical, and theoretical work in a variety of disciplines and professions is resulting in major paradigm changes, seen even as representing a "new scientific rationality" and an "opening up of a new theoretical space" (Ilya Prigogine).

Basic features in these paradigmatic changes imply both a reaction against and, more importantly, a going beyond fundamental canons of the classical Western scientific tradition. Henri Laborit goes as far as denouncing "an infantile belief in a direct cause-and-effect relationship completely unsuited to the sciences of such complex systems as those of living organisms"; Prigogine announces the belief shared by an increasing number of scientists that the fundamental laws of nature are irreversible and stochastic and that the traditional deterministic and reversible laws are applicable only to limited situations. Thus, the basic assumptions and models in the classical scientific tradition appear, in the light of the new perspectives, to be mechanistic, linear, closed, and reductionist. In the new emerging approaches, instability, openness, fluctuation, disorder, fuzziness, and creativity are built into scientific representations of reality, as are contradiction, ambiguity, and paradox. There is in these new approaches a fundamental shift from the simple to the complex, from structure to process. The new models concern non-equilibrium physics, dynamic open systems, dissipative structures, the creation of order out of noise, and complexity out of disorder. The implications are far-reaching. Rationality is no longer identified with certainty, nor probability with ignorance. Complexity and unpredictability are recognized as intrinsic features of systems as diverse as the world climate and the human brain. Complex

systems are seen as evolving in an evolutionary process in which both stochastic and deterministic factors play a vital role.

While, admittedly, most of the approaches that are focused on complexity seem to have arisen in the natural sciences or in new areas of research, there is, according to some analysts, a need to put these new ideas in a historical perspective and reveal the commonalities in different disciplines, including the approaches to complexity that have developed independently in the social and human sciences. It seems clear that the study of complexity cannot remain within the confines of a single discipline; that it demands a cross- or trans-disciplinary approach, and even leads to the obliteration of what are by some scholars perceived as artificial or reductionist barriers caused by the "arbitrary" classification of knowledge represented by traditionally defined scientific disciplines.

But while there seems to have occurred a surprising degree of spontaneous convergence around the concept of complexity, there are deep-seated differences in approach and conclusions even among those most profoundly and intimately involved as well as cleavages and traps for the unwary. Thus, spontaneously arising concern with complexity does not imply that cleavages along disciplinary fault-lines are not occurring or will not occur. Also, Montpellier seemed to indicate another cleavage, this one along culture fault-lines: it seemed, sometimes, that those of an "Anglo-American" background had difficulties entering the realm of discourse of French culture and vice versa. This aspect must, therefore, be given special attention when dealing with perceptions of complexity in a wider multicultural context, taking into account the distinct modes of perception and knowing elaborated through millenia in diverse cultures.

Key Concepts and Issues

Against this background, it seems possible to start identifying foci in the new perspectives, drawing upon key concepts used and key issues addressed. The following would be included in such a sample.

First, key issues are reflected in a loose cluster of principles and emerging paradigms that are defined by concepts such as the interrelationship between order and disorder, the creation of ever-increasing complex orders out of noise, disorder, and even chaos; autopoiesis, self-regulation, and spontaneous self-organization in natural and social systems, and also in artificial systems.

Inherent in these concepts is a reaction against determinism, a new acceptance of instability, chance, possibility, and of stochastic processes, a new emphasis on the emergence of the unexpected, the novel, the creative — and of new significance and meaning.