A THOUSAND YEARS OF NONLINEAR HISTORY

Manuel De Landa

Swerve Editions New York 2000

Introduction

Despite its title, this is not a book of history but a book of philosophy. It is, however, a deeply historical philosophy, which holds as its central thesis that all structures that surround us and form our reality (mountains, animals and plants, human languages, social institutions) are the products of specific historical processes. To be consistent, this type of philosophy must of necessity take real history as its starting point. The problem is, of course, that those who write history, however scholarly, do so from a given philosophical point of view, and this would seem to trap us in a vicious circle. But just as history and philosophy may interact in such a way as to make an objective assessment of reality impossible—when entrenched worldviews and routine procedures for gathering historical evidence constrain each other negatively—they can also interact positively and turn this mutual dependence into a virtuous circle. Moreover, it may be argued that this positive interaction has already begun. Many historians have abandoned their Eurocentrism and now question the very rise of the West (Why not China or Islam? is now a common question), and some have even left behind their anthropocentrism and include a host of nonhuman histories in their accounts. A number of philosophers, for their part, have benefited from the new historical evidence that scholars such as Fernand Braudel and William McNeill have unearthed, and have used it as a point of departure for a new, revived form

of materialism, liberated from the dogmas of the past.

Philosophy is not, however, the only discipline that has been influenced by a new awareness of the role of historical processes. Science, too, has acquired a historical consciousness. It is not an exaggeration to say that in the last two or three decades history has infiltrated physics, chemistry, and biology. It is true that nineteenth-century thermodynamics had already introduced time's arrow into physics, and hence the idea of irreversible historical processes. And the theory of evolution had already shown that animals and plants were not embodiments of eternal essences but piecemeal historical constructions, slow accumulations of adaptive traits cemented together via reproductive isolation. However, the classical versions of these two theories incorporated a rather weak notion of history into their conceptual machinery: both classical thermodynamics and Darwinism admitted only one possible historical outcome, the reaching of thermal equilibrium or of the fittest design. In both cases, once this point was reached, historical processes ceased to count. In a sense, optimal design or optimal distribution of energy represented an end of history for these theories.

It should come as no surprise, then, that the current penetration of science by historical concerns has been the result of advances in these two disciplines. Ilya Prigogine revolutionized thermodynamics in the 1960s by showing that the classical results were valid only for closed systems, where the overall quantities of energy are always conserved. If one allows an intense flow of energy in and out of a system (that is, if one pushes it *far from equilibrium*), the number and type of possible historical outcomes greatly increases. Instead of a unique and simple form of stability, we now have multiple coexisting forms of varying complexity (static, periodic, and chaotic *attractors*). Moreover, when a system switches from one stable state to another (at a critical point called a *bifurcation*), minor fluctuations may play a crucial role in deciding the outcome. Thus, when we study a given physical system, we need to know the specific nature of the fluctuations that have been present at each of its bifurcations; in other words, we need to know its history to understand its current dynamical state.[1]

And what is true of physical systems is all the more true of biological ones. Attractors and bifurcations are features of any system in which the dynamics are not only far from equilibrium but also *nonlinear*, that is, in which there are strong mutual interactions (or feedback) between components. Whether the system in question is composed of molecules or of living creatures, it will exhibit endogenously generated stable states, as well as sharp transitions between states, as long as there is feedback and an intense flow of energy coursing through the system. As biology begins to include these nonlinear dynamical phenomena in its models—for example, the mutual stimulation involved in the case of evolutionary "arms races" between predators and prey—the notion of a "fittest design" will lose its meaning. In an arms race there is no optimal solution fixed once and for all, since the criterion of "fitness" itself changes with the dynamics.[2] As the belief in a fixed criterion of optimality disappears from biology, real historical processes come to reassert themselves once more.

Thus, the move away from energetic equilibrium and linear causality has reinjected the natural sciences with historical concerns. This book is an exploration of the possibilities that might be opened to philosophical reflection by a similar move in the social sciences in general and history in particular. These pages explore the possibilities of a nonlinear and nonequilibrium history by tracing the development of the West in three historical narratives, each starting roughly in the year 1000 and culminating in our own time, a thousand years later. But doesn't this approach contra-

dict my stated goal? Isn't the very idea of following *a line of developmen* century by century, inherently linear? My answer is that a nonlinear co ception of history has absolutely nothing to do with a style of presentation, as if one could truly capture the nonequilibrium dynamics of hum historical processes by jumping back and forth among the centuries. O the contrary, what is needed here is not a textual but a physical operation: much as history has infiltrated physics, we must now allow physic to infiltrate human history.

Earlier attempts in this direction, most notably in the pioneering worl the physicist Arthur Iberall, offer a useful illustration of the conceptual shifts that this infiltration would involve. Iberall was perhaps the first t visualize the major transitions in early human history (the transitions fr hunter-gatherer to agriculturalist, and from agriculturalist to city dwell *not* as a linear advance up the ladder of progress but as the crossing o nonlinear critical thresholds (bifurcations). More specifically, much as given chemical compound (water, for example) may exist in several distinct states (solid, liquid, or gas) and may switch from stable state to stable state at critical points in the intensity of temperature (called *pha transitions*), so a human society may be seen as a "material" capable o undergoing these changes of state as it reaches critical mass in terms of density of settlement, amount of energy consumed, or even intensit of interaction.

Iberall invites us to view early hunter-gatherer bands as gas particles the sense that they lived apart from each other and therefore interact rarely and unsystematically. (Based on the ethnographic evidence that bands typically lived about seventy miles apart and assuming that hum can walk about twenty-five miles a day, he calculates that any two banc were separated by more than a day's distance from one another.[3]) Wh humans first began to cultivate cereals and the interaction between human beings and plants created sedentary communities, humanity liq fied or condensed into groups whose interactions were now more frequ although still loosely regulated. Finally, when a few of these communiti intensified agricultural production to the point where surpluses could b harvested, stored, and redistributed (for the first time allowing a divisi of labor between producers and consumers of food), humanity acquire a crystal state, in the sense that central governments now imposed a sy metrical grid of laws and regulations on the urban populations.[4]

However oversimplified this picture may be, it contains a significant c as to the nature of nonlinear history: if the different "stages" of humar history were indeed brought about by phase transitions, then they are not "stages" at all—that is, progressive developmental steps, each bet than the previous one, and indeed leaving the previous one behind. On the contrary, much as water's solid, liquid, and gas phases may coexist, so each new human phase simply added itself to the other ones, coexisting and interacting with them without leaving them in the past. Moreover, much as a given material may solidify in alternative ways (as ice or snowflake, as crystal or glass), so humanity liquefied and later solidified in different forms. The nomads of the Steppes (Huns, Mongols), for example, domesticated animals not plants, and the consequent pastoral lifestyle imposed on them the need to move with their flocks, almost as if they had condensed not into a pool of liquid but into a moving, at times turbulent, fluid. When these nomads did acquire a solid state (during the reign of Genghis Khan, for instance), the resulting structure was more like glass than crystal, more amorphous and less centralized. In other words, human history did not follow a straight line, as if everything pointed toward civilized societies as humanity's ultimate goal. On the contrary, at each bifurcation alternative stable states were possible, and once actualized, they coexisted and interacted with one another.

I am aware that all we have here are suggestive metaphors. It is the task of the various chapters of this book to attempt to remove that metaphorical content. Moreover, even as metaphors, Iberall's images suffer from another drawback: inorganic matter-energy has a wider range of alternatives for the generation of structure than just these simple phase transitions, and what is true for simple "stuff" must be all the more so for the complex materials that form human cultures. In other words, even the humblest forms of matter and energy have the potential for *self-organization* beyond the relatively simple type involved in the creation of crystals. There are, for instance, those coherent waves called *solitons*, which form in many different types of materials, ranging from ocean waters (where they are called tsunamis) to lasers. Then there are the aforementioned stable states (or attractors), which can sustain coherent cyclic activity of different types (periodic or chaotic).[5] Finally, and unlike the previous examples of nonlinear self-organization where true innovation cannot occur, there is what we may call "nonlinear combinatorics," which explores the different combinations into which entities derived from the previous processes (crystals, coherent pulses, cyclic patterns) may enter. It is from these unlimited combinations that truly novel structures are generated.[6] When put together, all these forms of spontaneous structural generation suggest that inorganic matter is much more variable and creative than we ever imagined. And this insight into matter's inherent creativity needs to be fully incorporated into our new materialist philosophies.

While the concept of self-organization, as applied to purely material and energetic systems, has been sharpened considerably over the las three decades, it still needs to be refined before we can apply it to the case of human societies. Specifically, we need to take into account tha any explanation of human behavior must involve reference to irreducib intentional entities such as "beliefs" and "desires," since expectations and preferences are what guide human decision making in a wide rang of social activities, such as politics and economics. In some cases the decisions made by individual human beings are highly constrained by their position and role in a hierarchical organization and are, to that ex tent, geared toward meeting the goals of that organization. In other case however, what matters is not the planned results of decision making, but the *unintended collective consequences* of human decisions. The be illustration of a social institution that emerges spontaneously from the interaction of many human decision makers is that of a pre-capitalist market, a collective entity arising from the decentralized interaction of many buyers and sellers, with no central "decider" coordinating the whole process. In some models, the dynamics of markets are governe by periodic attractors, which force markets to undergo boom-and-bust cycles of varying duration, from three-year business cycles to fifty-year long waves.

Whether applied to self-organized forms of matter-energy or to the u planned results of human agency, these new concepts demand a new methodology, and it is this methodological change that may prove to b philosophical significance. Part of what this change involves is fairly ob ous: the equations scientists use to model nonlinear processes cannot solved by hand, but demand the use of computers. More technically, u like linear equations (the type most prevalent in science), nonlinear on are very difficult to solve *analytically*, and demand the use of detailed numerical simulations carried out with the help of digital machines. Th limitation of analytical tools for the study of nonlinear dynamics becom even more constraining in the case of nonlinear combinatorics. In this case, certain combinations will display *emergent properties*, that is, pro erties of the combination as a whole which are more than the sum of its individual parts. These emergent (or "synergistic") properties belon to the *interactions between parts*, so it follows that a top-down analytical approach that begins with the whole and dissects it into its constituent parts (an ecosystem into species, a society into institutions), is bound t miss precisely those properties. In other words, analyzing a whole into parts and then attempting to model it by *adding up* the components wil fail to capture any property that emerged from complex interactions, since the effect of the latter may be multiplicative (e.g., mutual enhancement) and not just additive.

Of course, analytical tools cannot simply be dismissed due to this inherent limitation. Rather, a top-down approach to the study of complex entities needs to be *complemented* with a bottom-up approach: analysis needs to go hand in hand with synthesis. And here, just as in the case of nonlinear dynamics, computers offer an indispensable aid. For example, instead of studying a rain forest top down, starting from the forest as a whole and dividing it into species, we unleash within the computer a population of interacting virtual "animals" and "plants" and attempt to generate from their interactions whatever systematic properties we ascribe to the ecosystem as a whole. Only if the resilience, stability, and other properties of the whole (such as the formation of complex food webs) emerge spontaneously in the course of the simulation can we assert that we have captured the nonlinear dynamics and combinatorics of rain forest formation. (This is, basically, the approach taken by the new discipline of Artificial Life.[7])

In this book, I attempt a philosophical approach to history which is as bottom-up as possible. This does not mean, of course, that every one of my statements has emerged after careful synthetic simulations of social reality. I do take into account the results of many bottom-up simulations (in urban and economic dynamics), but research in this direction is still in its infancy. My account is bottom-up in that I make an effort not to postulate systematicity when I cannot show that a particular system-generating process has actually occurred. (In particular, I refrain from speaking of society as a whole forming a system and focus instead on subsets of society.) Also, I approach entities at any given level (the level of nation-states, cities, institutions, or individual decision makers) in terms of *populations* of entities at the level immediately below.

Methodologically, this implies a rejection of the philosophical foundations of orthodox economics as well as orthodox sociology. Although the former (neoclassical microeconomics) begins its analysis at the bottom of society, at the level of the individual decision maker, it does so in a way that atomizes these components, each one of which is modeled as maximizing his or her individual satisfaction ("marginal utility") in isolation from the others. Each decision maker is further atomized by the assumption that the decisions in question are made on a case-by-case basis, constrained only by budgetary limitations, ignoring social norms and values that constrain individual action in a variety of ways. Orthodox sociology (whether functionalist or Marxist-structuralist), on the other hand, takes society as a whole as its point of departure and only rarely

attempts to explain in detail the exact historical processes through wl collective social institutions have emerged out of the interactions amc individuals.

Fortunately, the last few decades have witnessed the birth and gro of a synthesis of economic and sociological ideas (under the banner c "neoinstitutional economics"), as exemplified by the work of such au as Douglas North, Viktor Vanberg, and Oliver Williamson. This new sc (or set of schools) rejects the atomism of neoclassical economists as as the holism of structuralist-functionalist sociologists. It preserves "n odological individualism" (appropriate to any bottom-up perspective) rejects the idea that individuals make decisions solely according to se interested (maximizing) calculations, and instead models individuals rule followers subjected to different types of normative and institutio constraints that apply collectively. Neoinstitutionalism rejects the "me dological holism" of sociology but preserves what we may call its "ont logical holism," that is, the idea that even though collective institutior emerge out of the interactions among individuals, once they have for they take on "a life of their own" (i.e., they are not just reified entities and affect individual action in many different ways.[8]

Neoinstitutionalist economists have also introduced sociological co cepts into economics by replacing the notion of "exchange of goods" the more complex one of "transaction," which brings into play differe kinds of collective entities, such as institutional norms, contracts, anc enforcement procedures. Indeed, the notion of "transaction" may be to add to linear economics some of the "friction" that its traditional m els usually leave out: imperfections in markets due to limited rational imperfect information, delays and bottlenecks, opportunism, high-cos enforceability of contracts, and so on. Adding "transaction costs" to t classical model is a way of acknowledging the continuous presence of linearities in the operation of real markets. One of the aims of the pre book is to attempt a synthesis between these new ideas and methodc gies in economics and the corresponding concepts in the sciences of organization.[9]

In Chapter One I approach this synthesis through an exploration of the history of urban economics since the Middle Ages. I take as my pc of departure a view shared by several materialist historians (principal Braudel and McNeill): the specific dynamics of European towns were important reason why China and Islam, despite their early economic technological lead, were eventually subjected to Western domination. Given that an important aim of this book is to approach history in a n teleological way, the eventual conquest of the millennium by the West will not be viewed as the result of "progress" occurring there while failing to take place outside of Europe, but as the result of certain dynamics (such as the mutually stimulating dynamics involved in arms races) that intensify the accumulation of knowledge and technologies, and of certain institutional norms and organizations. Several different forms of mutual stimulation (or of "positive feedback," to use the technical term) will be analyzed, each involving a different set of individuals and institutions and evolving in a different area of the European urban landscape. Furthermore, it will be argued that the Industrial Revolution can be viewed in terms of reciprocal stimulation between technologies and institutions, whereby the elements involved managed to form a closed loop, so that the entire assemblage became self-sustaining. I refer to this historical narrative as "geological" because it concerns itself exclusively with dynamical elements (energy flow, nonlinear causality) that we have in common with rocks and mountains and other nonliving historical structures.

Chapter Two addresses another sphere of reality, the world of germs, plants, and animals and hence views cities as ecosystems, albeit extremely simplified ones. This chapter goes beyond questions of inanimate energy flow, to consider the flows of organic materials that have informed urban life since the Middle Ages. In particular, it considers the flow of food, which keeps cities alive and in most cases comes from outside the town itself. Cities appear as parasitic entities, deriving their sustenance from nearby rural regions or, via colonialism and conquest, from other lands. This chapter also considers the flow of genetic materials through generations—not so much the flow of human genes as those belonging to the animal and plant species that we have managed to domesticate, as well as those that have constantly eluded our control, such as weeds and microorganisms. Colonial enterprises appear in this chapter not only as a means to redirect food toward the motherland, but also as the means by which the genes of many nonhuman species have invaded and conquered alien ecosystems.

Finally, Chapter Three deals with the other type of "materials" that enter into the human mixture: linguistic materials. Like minerals, inanimate energy, food, and genes, the sounds, words, and syntactical constructions that make up language accumulated within the walls of medieval (and modern) towns and were transformed by urban dynamics. Some of these linguistic materials (learned, written Latin, for example) were so rigid and unchanging that they simply accumulated as a dead structure. But other forms of language (vulgar, spoken Latin) were dynamic entities capable of giving birth to new structures, such as French, Spanish, Italian, and Portuguese. This chapter traces the history of

these emergences, most of them in urban environments, as well as of eventual rigidification (through standardization) of the dialects belong to regional and national capitals, and of the effects that several gener tions of media (the printing press, mass media, computer networks) h had on their evolution.

Each chapter begins its narrative in the year 1000 A.D. and continu (more or less linearly) to the year 2000. Yet, as I said above, despite t style of presentation, these three narratives do not constitute a "real" history of their subjects but rather a sustained philosophical meditatic on some of the historical processes that have affected these three typ of "materials" (energetic, genetic, and linguistic). The very fact that ea chapter concentrates on a single "material" (viewing human history, a it were, from the point of view of that particular material) will make th narratives hardly recognizable as historical accounts. Yet, most of the generalizations to be found here have been made by historians and a not the product of pure philosophical speculation.

In the nonlinear spirit of this book, these three worlds (geological, b logical, and linguistic) will *not* be viewed as the progressively more sop ticated stages of an evolution that culminates in humanity as its crow achievement. It is true that a small subset of geological materials (car bon, hydrogen, oxygen, and nine other elements) formed the substrat needed for living creatures to emerge and that a small subset of orga materials (certain neurons in the brain) provided the substratum for la guage. But far from advancing in stages of increased perfection, thes successive emergences were—and will be treated here as—mere accu lations of different types of materials, accumulations in which each su cessive layer does not form a new world closed in on itself but, on the contrary, results in coexistences and interactions of different kinds. B sides, each accumulated layer is animated from within by self-organiz processes, and the forces and constraints behind this spontaneous generation of order are common to all three.

In a very real sense, reality is *a single matter-energy* undergoing pha transitions of various kinds, with each new layer of accumulated "stuf simply enriching the reservoir of nonlinear dynamics and nonlinear co binatorics available for the generation of novel structures and process Rocks and winds, germs and words, are all different manifestations of this dynamic material reality, or, in other words, they all represent the ferent ways in which this single matter-energy *expresses itself*. Thus, w follows will not be a chronicle of "man" and "his" historical achieveme but a philosophical meditation on the history of matter-energy in its di ferent forms and of the multiple coexistences and interactions of thes forms. Geological, organic, and linguistic materials will all be allowed to "have their say" in the form that this book takes, and the resulting chorus of material voices will, I hope, give us a fresh perspective on the events and processes that have shaped the history of this millennium.

1: LAVAS AND MAGMA