

DIALECTICS, COMPLEXITY AND THE CRISIS

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Much about current political life is hardly encouraging. They can call it the New World Order if they want to, but the collapse of the USSR, the growth of right wing militias in the U.S., the transformation several years ago of "Operation Hope" into military conflict in Somalia and the more recent carnage in former Yugoslavia are all prominent examples of the chaotic character of the moment. The formerly stable is crumbling and everywhere things appear to be getting worse. Unemployment, violence and poverty are all increasing. No solution appears forthcoming from those in power or their loyal opposition. The abruptness of change, the radical rupture with the past, is everywhere. Many scientists, especially those involved in progressive political activity, are trying to find meaning in the current chaos. How should they understand the crisis? The continuous, incremental perspective on development, however useful it may be to describe gradual development, does not apply here. Yet, this is the perspective on how change occurs which has dominated much of social and natural science until recently.

Meanwhile, a revolution is sweeping all areas of modern science. Its source is electronic. Everywhere, the computational capability of computers is providing access to previously unavailable quantities of information. As a result, patterns of development of diverse processes are becoming known. The most recent expression of the new discoveries is the so-called "new science" of complexity. It finds common patterns of motion among quite different processes known as complex dynamic systems.

COMPLEXITY

Complexity is a clear assertion that development is not exclusively or, even, mainly continuous. It is a rebuttal, or, perhaps, an extension of the classic, gradual view of development characterized by Newton or Darwin. In fact, evolution is one of the main subjects where there has been a recognition that development occurs in leaps which punctuate periods of gradual growth. The rapid

emergence of multicellular life forms in the so-called Cambrian explosion some 600 millions years ago contradicts the formerly held assumptions of gradualism postulated by Darwin. These discoveries, popularized by Stephen Jay Gould (Gould, 1989), could be accomplished because of the availability of electronic reconstruction processes as well as the creativity of the discoverers.[1] The resulting debate about the dynamic of evolution, the role of natural selection, and the existence of pre-established limits or attractors to complex evolutionary systems continues.

A similar issue regarding attractors can be posed about society. Is history just "one damn thing after another", as Churchill put it, or are there definite indispensable phases through which it must pass? Are there attractors in the complex dynamic process of human society? Were, say, large scale factory production or the social formations corresponding to it inevitable? Are exploitation and poverty inevitable? Is it at least possible to overcome them? Complexity provides a scientific framework within which to raise such questions.

Complexity makes extremely general claims about development, the emergence of new things from old, etc. At least some of its advocates and detractors discuss it in terms of a search for a "theory of everything". As such, it is met with studied skepticism and opposition by portions of the scientific community (Horgan, 1995). Nonetheless, complexity is a philosophic framework with substantial precedent in the computer age. Chaos Theory, Catastrophe Theory and Fractal Geometry all are theoretical perspectives which have emerged within the past twenty or so years which view development as emergent, discontinuous or abrupt. They all, to some extent, anticipate complexity.

The significance of complexity does not rest with any particular discovery or hypothesis.[2] The value of complexity is that of a general philosophic outlook which attempts to capture the insights which modern electronics is revealing about nature and society. The dependence of its subject matter on electronic technology is acknowledged in the following passage which also indicates the breadth of application of the underlying concepts:

Fractals and modern chaos theory are also linked by the fact that many of the contemporary pace setting discoveries in their fields were only possible using computers..(It is already clear that the history of the sciences has been enriched by an indispensable chapter. Only superficially is the issue one of beautiful pictures or of perils of deterministic laws. In essence, chaos theory and fractal

geometry radically question our understanding of equilibria - and therefore of harmony and order - in nature as well as in other contexts and offer a new and holistic model which can encompass an edge of the true complexity of nature for the first time. It is highly probable that the new methods and terminologies will allow us, for example, a much more adequate understanding of ecology and climatic developments, and thus they could contribute to our more effectively tackling our gigantic global problems. (Pietgen, Jurgens, Saupe 1992).

Complexity proposes a view of the continuity/discontinuity of development in numerous contexts. The general pattern its adherents describe includes: the emergence of global structure from local, simple interactions; the inter-connection of phenomena; the continuous linear development of a process to the point of maximum information processing capability, where it remains poised at the so-called "edge of chaos" until further information enters the system, disrupts stability and ushers in a leap to a new situation; the emergence of global order and structure via chaotic, random activity; the existence of limits or end results of dynamic processes known as attractors.

Information processing capability is a variable which complexity theorists use to measure the degree of development of complex adaptive systems. As systems evolve, information processing grows gradually to a point, the so-called "edge of chaos", where stability is challenged by further information: "The edge of chaos is where information gets its foot in the door in the physical world, where it gets the upper hand over energy" (C. Langdon in Lewin, 1992, p. 51). This concept arose from generalizing computer simulations (of consciousness development, species evolution and other phenomena). It plays a central role in the perspective on change of complexity. It provides a useful interpretation for the development of society.

The areas of applicability of complexity are extremely diverse. Physicist Per Bak of the Brookhaven National Laboratory notes earthquake distributions, stock market fluctuations, and species extinction patterns among the phenomena that display similar general patterns corresponding to complexity theory. Also included are the artificial intelligence models of Sante Fe Institute member Chris Langdon, the Boolean networks of University of Pennsylvania biologist Stuart Kauffman and the interpretations of both biological and cultural evolution by Nobel laureate Murray Gell-man.

Human society is the most obvious example of a complex adaptive system. It is obviously both complex and adaptive. It has reorganized itself throughout history to facilitate its capability to

process information for social purposes. For example, the transition from feudal, principally rural social forms to capitalist, principally urban ones allowed for the eventual application of science to industry during the 18th and 19th centuries. The process was anything but orderly and peaceful. On the contrary, the forcible removal of the agricultural population from the land, their means of subsistence, was disorderly, violent and often bloody. The enclosure of lands formerly used in common simultaneously transformed the land into sheep-walks and the population into an urban working class. Then, social disorganization prepared society for social reorganization. Does the present disarray have a similar content?

The relation between chaos and structure is a central issue for the "new science" which has immediate social application. Does the development of societies proceed to their maximum information processing capability at the so-called "edge of chaos"? Does further excitation there give rise to a chaotic transition to a new state of higher information processing capability (higher complexity)? This description is fully consistent with the evolutionary perspective of complexity theory. It is also a view of the present period as a prelude, or, at least a possible prelude, to a more cooperative, more conscious social order. The proof, of course, will be in the pudding. The point is only that the conclusions of modern complexity are consistent with an optimistic understanding of current events, in spite of the images and reality of "chaos".

Complexity provides a philosophic framework for analyzing the current crisis. Chris Langdon, one of the discoverers of the concept of "the edge of chaos" sees complexity-like patterns in the current situation. Commenting on the likely effects of the decline of the USSR in October 1991, he refers to a computer based evolution model: "You can see these two species coexisting in a long period of stability; then one of them drops out and all hell breaks loose. Tremendous instability. That's the Soviet Union" he'd said, pointing to the species that dropped out. "I'm no fan of the Cold War, but my bet is that we're going to see a lot of instability in the real world now that it's over. That is, if these models of ours have any validity at all" (quoted in Lewin, 1992). To take this important insight further, a concrete investigation of current social motion is needed. For the rich potential of complexity to be utilized to understand current social development requires more than the recognition of a common "complex" pattern shared with other complex adaptive systems. The devil is in the details. To really evaluate what is going on, it is necessary to identify what it is that gives the present its character and direction. The actual basis for the dynamics of social development must be disclosed and analyzed.

This has not taken place among the adherents of complexity. There are archeological analyses of the stages of development of ancient societies as exhibiting "... attractors equivalent to discrete levels of organization, like the tribe, the cheifdom, the state" (Lewin, 1992, p. 21). But, as far as application to the current social crisis, complexity theorists have little to say. What analysis of the present that is being done deals with discrete issues. Stock market equilibrium or lack thereof, comparative advantage of particular commodities, foreign trade balances among others have all been investigated from the standpoint of complexity. They are dealt with as isolates even though the approach of complexity emphasizes the interconnection of phenomena.

Significantly, the implied context of this work has been the assumed permanence of the capitalist form of social organization. Yet, the basic principles of complexity include the recognition that the edge of chaos is a place where qualitative distinctness can emerge. This possibility is simply overlooked. Why are these basic tenets disregarded in favor of such conservative assumptions? Do the interests of the corporate sponsors of much complexity research prejudice investigation? Most important, how can these limitations be overcome? How can the insights of complexity be made available for an analysis of the current crisis?

For the philosophic outlook of complexity to be applied to such efforts it is helpful, maybe even necessary, to regard complexity in relation to its historical antecedents. Both as a philosophic methodology and in its application to social analysis, the dialectical materialism associated with Karl Marx and Frederick Engels is an appropriate predecessor. This connection is demonstrable. The patterns and principles of development that comprise complexity are generalizations of structures which are accessible to analysis via electronics. They are also fully consistent applications of dialectics. It is not that complexity represents nothing new. As science progresses so does philosophy. The point isn't to choose the 'right' term for a philosophic outlook and methodology, "Is it dialectics or is it complexity?". Rather, it is to recognize a real and useful connection in the history of science and philosophy. The connection is important for two reasons: (i) It allows the projections of Marxism to be evaluated in the context of modern science; and (ii) it demystifies complexity by connecting it to past accomplishments.

COMPLEXITY AND DIALECTICAL MATERIALISM

Materialism is the acknowledgment that the world is real and knowable, that its existence does not stand in need of any "other worldly" act of creation nor require the existence of any "ideal" source for its maintenance. In so far as its methodology and assumptions are concerned, modern science, in general, accepts the outlook of materialism. It is worth pointing out that, as Galileo's case bears witness, this has not always been the case nor is it unconditionally the accepted standard currently. Roger Lewin discusses two contemporary non materialist views of the failure of science to fully explain human consciousness. Not surprisingly, one invokes "a supernatural spiritual creation", "a miracle forever beyond science" and the other asserts materialism but contends that the truth of the issue is ultimately unknowable (Lewin, 1992 p. 154, 167). Still, materialist views are world-wide and ancient. A pre-Socratic summation by Heraclitus imaginatively summarizes the concept: "This order of things, the same for all, was not made by any god nor any man, but was and is and will be for ever, a living fire, kindled by measure and quenched by measure" (Leningrad Institute of Philosophy, 1937).

Now for dialectics. Dialectical philosophy aspires to generalize the way that things change and develop. It acknowledges that things do not change in isolation from each other but in their inter-connection with each other. As Frederick Engels put it, dialectics is "the science of interconnections" (Engels, 1972, p. 62). Dialectics itself changes or, at least, our understanding of it does. As advances in science, including social science, disclose the patterns and connections among things that allow them to develop, dialectical philosophy is correspondingly developed. Dialectical materialism is a useful philosophic orientation which is not generally well known. We recommend two excellent, very different, modern discussions of dialectics in *The Dialectical Biologist* by Levins and Lewontin and in *Entering an Era of Social Revolution* by Peery. Levins and Lewontin's presentation of dialectics emphasizes natural science. Peery mainly applies dialectics to social transformation. From the standpoint of dialectical philosophy, he analyzes the possibility of the emergence of a qualitatively new, cooperative society from the current situation. Each discussion contains insights which rest upon those of traditional dialectics; each deepens them by consideration of modern information. Levins and Lewontin indicate the historical character of dialectics when they acknowledge their indebtedness to Engels, to whom they dedicate their book, while recognizing the nineteenth century limitations of his scientific perspective (Levins and

Lewontin p. 279). We refer the reader to either source for information about dialectics as such. Our interest here is the development of dialectics in its relation to complexity.

Complexity studies (among other things) the relation between order and chaos and the emergence of structure from random processes. Random individual outcomes often comprise the content of deterministic patterns. Thus, many processes have a global structure which emerges from individual randomness (Ask any poker player!). This inter-connection between the apparent mutually isolated categories, "random" and "deterministic" is the basis for much of the theory of probability and statistics. Its philosophic generality was noted by Engels more than a century ago as "...the necessity that is also inherent in chance." It is discussed as an example of dialectics by Levins and Lewontin: "(R)andom processes may have deterministic results. This is the basis for predictions about the number of traffic accidents or for actuarial tables. A random process results in some frequency distribution of outcomes...(T)he distribution as an object of study is deterministic even though it is the product of random events" (p. 284).

What is new which complexity considers are the numerous examples which electronic computers reveal of determinist outcomes that are now known to evolve from random processes. From "artificial intelligence" or species evolution models to mathematical fractals, quite complex deterministic structures can be shown to emerge from random processes. Complexity theory examines such emergence as a general principle. A debate, with important social implications regarding the nature of human progress, is ensuing among scientists about under what circumstances the eventual outcome (the limit or attractor) of a complex process can be said to exist.

What is also new and most significant are the cases in which random and/or initially tiny changes in complex dynamic systems disrupt the expected, determined outcome. The unstable situation in which small changes in a process initiate a chaotic leap to a qualitatively new process is being revealed as a discontinuous aspect of development in nature and society. Perhaps the best known example of discontinuity under appropriate conditions is the so-called Butterfly Effect named after an article by the physicist E. Lorenz: "Can the Flap of a butterfly's wing stir up a tornado in Texas?" (Answer: Sometimes, but not often). In this example and significant others, discontinuity and leaps to new states of being are revealed as an essential aspect of real motion. This recognition has a history within dialectics. It is of tremendous importance to any attempt to uncover the causes of the

current social disintegration and where it might be headed.

The conception of development through leaps has always been part of dialectics. Engels discussed "...the Hegelian nodal line of measure relations, in which, at certain definite nodal points, the purely quantitative increase or decrease gives rise to a qualitative leap..." In many particular cases, however, sufficient information about the actual emergence of the new from the old often was not accessible. Electronics has changed this situation. The introduction of electronics into the social and scientific environments is both causing qualitative changes and making them more visible. Thus, it is becoming possible to more deeply describe the emergence of the qualitatively new.

One such description is the concept in complexity theory of "the edge of chaos" originated by Chris Langdon and Norman Packard. Their main area of application has been in the physical sciences. Another is the dialectical assertion by Nelson Peery that qualitative leaps begin with the introduction of an aspect of the new process into the quantitative development of the old process. His main application is to current social development. He identifies electronic technology as both disrupting the nexus that binds together the capitalist class and the working class, and providing the technical basis for post-capitalist society (see below). These two conceptions are similar, although not identical. They both attempt to account for the emergence of new phenomena. They each identify a process wherein, at a certain stage of development, the introduction of further change topples the existing stability and ushers in a chaotic period leading to qualitative change. They are mutually consistent criteria for the occurrence of qualitative leaps. They demonstrate the connection between complexity and Marxist dialectics.

CAPITALISM AS A COMPLEX DYNAMIC SYSTEM

The most prominent application of dialectical materialism remains its use by Marx and Engels in analyzing how capitalist society works. It is a precursor to the approach of complexity which contains important theoretical conclusions that bear upon the present. Marx focuses on the simple exchange of commodities as the source of the development of capitalist society as a whole (Marx, 1973). From examination of this process, the Law of Value and, then, numerous other economic principles are derived. It is a useful example of the emergence of a complex adaptive system from

local interaction which characterizes complexity. It indicates the deep historical connection between complexity and Marxist dialectics. It is a valid starting point for applying the methodology of complexity and/or dialectics to analyze the current situation.

We proceed from Marx's recognition that capital is a social relation. It is not a dead thing. It is not machinery or land or whatever. Capital is a living relation among social classes. "Capital is a collective product...it is a social power" (Marx, 1982), a power which the capitalist class exerts over the working class. It arises from the exchange of commodities between the capitalist class and the working class. The only thing that the working class has to sell is its capacity to work, what Marx termed its labor power. The capitalist class purchases labor power from the working class and sells them necessities of life. Whatever each thinks of the other, during the period of growth of capitalism[3], they are bound together. They need each other. They are defined by each other through mutual exchange. As Marx showed in detail (Marx, 1967), the proportion in which this exchange occurs is regulated by the law of value, the same economic law that determines the exchange ratio between any other commodities.

Economic activity in capitalist society consists of the production and exchange of millions of individual commodities. The buyer needs the seller in order to buy and vice versa. Individual buyers try to buy low and individual sellers try to sell high. The Law of Value describes the general outcome of this struggle between contradictory economic interests. It assigns exchange value to individual commodities according to the quantity of labor necessary for their production. The relative value of commodities thus is determined by the relative quantities of labor required to produce them. The law of value asserts that, ultimately, the ratio in which commodities tend to exchange is determined by the proportion between their labor contents. Since exchange of commodities generally occurs through exchange of money, price becomes a form of expression of value. Thus, as the labor required to produce any given commodity falls (or rises), its price tends to do so as well.

Numerous empirical confirmations of this phenomenon are available from the past two centuries during which it has regulated the economic life of capitalist societies. For example, the cotton gin, by automating the removal of seeds and hulls from the cotton plant, lowered the quantity of labor necessary for cotton production. Thus, cotton could be economically produced, giving rise simultaneously to the ante-bellum slave system in the U.S. and the textile industry in Europe. After

the Civil War, sharecropping, a form of virtually involuntary labor, replaced slavery. It was only the invention of an automatic cotton picker after W.W.II that undercut the value of manual labor power in cotton production.

Presently, it remains true that the more technology that is applied to the production of a commodity, (i.e. the less labor that is required), the lower the price tends to be. How this tendency manifests itself in particular cases varies, but the general direction is observable. For example, to be affordable to a mass market, the early automobiles required labor saving assembly line methods of production (Rifkin, 1995, p. 95). Similarly, modern personal computers, VCRs, etc. could only be sold in massive quantities when electronics reduced the quantity of labor required to produce them. The less the labor, the less the cost - for cars, for PC's and, ultimately, for any commodity. In particular, for labor power. The cost of the labor power necessary for capitalist production is rapidly diminishing with drastic consequences for the workers of the world.

Prior to the advent of electronic technology, labor productivity (which grows inversely with the value of labor power) grew quantitatively. Manual labor, steam power, internal combustion and electricity mark some definitive stages of this development. Capitalism's expansion and the expansion of its market were a requirement for this process. It did expand. The colonial system, the Great Depression, W.W.II, the rebuilding of the war-torn (capitalist) countries and the dismantling of the direct colonies after the war were all dramatic events that permitted such expansion to occur. As they indicate, the process was not smooth and was often painful. But its essential content was the development of world capitalism through stages of growth. The capitalist system, itself, (see T. Hirschl's essay) was never seriously in danger.

As argued elsewhere in this volume as well as in Jeremy Rifkin's *The End of Work*, electronics is labor-eliminating. But can there be capitalism without labor? Labor is both the source of the survival of the working class and the enrichment of the capitalist class. Electronic production cheapens the value of the workers' labor power to the point where the operation of the law of value cannot sustain the relation between the capitalist class and the working class. The amount of labor required for profitable production can neither support the existence of the workers nor the productive investment of the capitalists. The connection between them is being torn asunder. A new class is emerging which can neither work nor consume. Social stability based on the availability of work is a thing of the past.

Note again the consistency of this analysis both with the approach of complexity and of dialectics. Society is poised at the "edge of chaos", with its information processing capability maximized when a qualitatively new element, electronic information processing, is introduced. Then, all hell breaks loose. Where do we go from here?

CONCLUSION

Society is not merely poised at the edge of chaos. Electronic technology is both labor-free and productive beyond the bounds of human necessity. Thus, the same source that disrupts the stability of capitalist society could liberate human society from its historic and, apparently, endemic scarcity and exploitation. The earliest projection of such human liberation on the basis of the negation of labor was by Marx:

"In all revolutions up till now the mode of activity always remained unscathed and it was always a question of a different distribution of this activity, a new distribution of labor to other persons, whilst the communist revolution is directed against the preceding mode of activity, does away with labor, and abolishes the rule of all classes with the classes themselves...." (Marx and Engels, 1976).

The interpretation of a cooperative, post-scarcity society based upon electronic production as an attractor for human society is consistent with Marx's formulation. So too is Peery's dialectical understanding of post-scarcity society emerging from the introduction of electronic production into capitalist society. Of course we cannot guarantee the future. We are only pointing out the consistency of the projection of a plentiful, cooperative, communist society with the perspectives of complexity and of dialectics. Science can only indicate what is possible. What will happen will be determined by what people do.

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NOTES

1. For a description of the indebtedness of current paleontology to electronic imaging see "Rethinking the Riddle of the Dinosaurs" in Newsweek, June 5, 1995
2. E.g., the conjectures of some of its advocates that complex adaptive systems conform to exponential power laws
3. Here we mean cyclical growth, including periodic crises of overproduction. The periodic nature of such crises implies the eventual recovery of the system.

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