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Complexity, Chaos, and Holism: The 'Scientific' Roots of a Post-Positivistic Social Science in the Twenty-First Century

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Abstract

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From post-modernism in the humanities and the social sciences to nonlinear dynamics and evolutionary complexity in the natural sciences, the philosophical and methodological challenges to mainstream social science's positivistic behaviorism have become unrelenting and critically pervasive, to such a degree that a significant paradigm shift to a post-positivistic world view is both demanded and possible. This paper seeks to elucidate in particular the "scientific" roots of such a post-positivistic paradigm, drawing primarily on the rather startling, yet ultimately enriching, developments in chaos theory and theories of complexity. In this new paradigm history, contingency, and evolutionary unpredictability regain fundamental scientific legitimacy; and, major tenets of positivism/behaviorism, such as objectivity, linear-mechanistic causality and predictability, and methodological individualism, are all fundamentally challenged by the scientific legitimizing of their philosophical-methodological opposites, subjectivity, non-linearity, collective agency and consciousness respectively.

I

At the risk of some over-generalizing caricature, if one were to designate what have been the essential "scientific roots" of twentieth or late twentieth century social sciences, particularly in the United States, the chances are that one would use the word "positivism" or "behaviorism", by which one would also mean (even if one was not conscious of it), again essentially, the scientific method, epistemology, and world-view of Newtonian-Cartesian, mechanistic-reductionistic physical science. After all, it was probably no accident that Comte, one of the founding fathers of what became twentieth century sociology, decided to name his scientific investigations of the social world, "social physics."[1]

Putting aside, at least for the moment, legitimate arguments about whether it is or is not appropriate to adopt "natural scientific" method, metaphor, epistemology, and world view for the "social sciences"[2], so far there is little exceptional about what has been said above. However, as one looks back over the history of the methodological[3] and metaphysical developments of the natural sciences in the twentieth century, from quantum physics[4] to the contemporary science of evolutionary complexity[5], it is glaringly apparent that the simplicity and somewhat uncontentious nature of my initial comments above about a Newtonian-inspired social science are patently out of date.

Again, putting aside questions of applicability and legitimacy vis-á-vis adopting Newtonianism for the social sciences, as social scientists we are no longer constrained to use Newtonian-Cartesianism's deterministic mechanism, under the guise of positivism or behaviorism, if we still want to be credentialled and legitimized as scientists according to "natural" scientific standards. It is not so much that positivism or behaviorism is "dead", as so many have prematurely and over-confidently asserted[6], but rather that what counts as being scientific, even in the natural sciences themselves, has greatly expanded in the twentieth century, so that as we sit poised to enter the twenty-first century a whole new set of methodological horizons open up before us, again, as scientists, natural and/or social. Today, the natural scientific community no longer shares one exclusive methodological canon, centered around a mechanistic Newtonian-Cartesianism; rather, in many ways, what counts for the natural scientific view of things methodological is increasingly open to vigorous and, I believe, enriching debate. Although Newtonian-Cartesianism, positivism, and behaviorism are not dead, or even necessarily "dying" in any literal sense of that word, their collective hegemony over the natural and the social sciences is most emphatically over. Today and in the twenty-first century, N-Cism[7] will have to move over to make room for some very non-N-C ways of looking at things. What I call the "new"[8] sciences of "chaos, complexity, and holism", while not totally eradicating N-C methodological mechanism and determinism, nevertheless challenge most radically many, if not all, of N-Cism's methodological and metaphysical postulates. In short, and as the title of this paper suggests, I believe that the scientific roots of the social sciences in the twenty-first century will be much less N-C-centered and articulated much more within the emerging holistic scientific paradigm of chaos and complexity theory.

II

In a paper of this size, of course, it is literally impossible to begin to fully delineate the metaphysical, epistemological, and methodological extent of the new sciences of chaos, complexity, and holism; this work has been done elsewhere in book-length treatments.[9] Accordingly, for the sake of brevity, what I propose to do here is to quickly summarize what I consider to be the most significant aspects of these new sciences, requesting of the reader at this point to "just take my word for it". What, then, *in brevis*, are the major methodological "radical challenges" of the new sciences, which will form the bedrock of the social sciences of the twenty-first century?[10]

1) A fundamental rejection of a long list of N-C-positivistic dualisms, and the reconciliation of them in a dialectical, relational (as opposed to atomistic) ontology. Among such dialectically mediated dualisms are:

a) parts and the whole (individual and society)

b) mind and matter

c) the implicate and the explicate

d) order and disorder

e) continuity and change

f) chance and determinism

g) simplicity and complexity

h) stability and instability

i) freedom and determinism

j) autonomy and dependence

k) rationality and intuition

l) the abstract and the real (or concrete)

m) subjectivism and objectivism

n) contingency and determinism

o) probability and determinism

p) flexibility and law-governed behavior

q) the incremental and the exponential

r) microcosm and macrocosm

s) openness and control

t) nature and nurture

u) the observer and the observed

v) causality and nonlocality

2) Parts or elements or individuals within a system or collectivity are not isolable or discrete phenomena, but are dialectically enfolded into the whole.

3) The abstract is at least as real as the material, if not more so. Ontological primacy belongs to the codes (genetic or linguistic-cultural, for instance), the information systems, and the networks of the relational, implicate whole. Raw empiricism as a foundation for reliable knowledge is replaced by an understanding of the open-ended implications of transformative grammars.

4) Methodological individualism makes some accommodation at least to a methodological holism, a legitimation of whole systems being actors and conscious agents (collective minds) with self-interests in their own right.

5) Subjectivism and an observer-created reality is the norm; a purely objectivist scientific stance is literally impossible. In a relational, holistic universe measurement itself alters and shapes and dynamically changes what it is supposed to be measuring.

6) The universe is stochastic. Its determinism is relativistic, context-driven, contingent, historically and environmentally mutable, and unpredictable. No universalistic (either spatial and/or temporal) laws of behavior govern the system as a whole. Stochastic systems enjoy a rule-governed flexibility and openness.

7) Order and disorder are not clearly demarcated; indeed, they, too, are enfolded or implicated in each other. Even the most turbulent conditions have an underlying order to them; disorder may be no more than highly complex behavior with a higher degree of order than the Newtonian machine is used to describing. A complex, highly relational system is no less ordered just because raw empiricism cannot appraise it.

8) Linear prediction is replaced by probability matrices in making system projections. Holistic systems co-evolve with their constituent "parts" along with their dynamic interrelationships and the laws that govern them. Contingency, systematic error, ambiguity, openness, and indeterminacy are,

therefore, inherent in non-linear, holistic systems. But this does not mean we live in ignorance or that totally unknowable systems are subject to inevitable breakdown. In fact, error tolerance, the amalgamation of positive and negative feedback loops, and systemic openness in general (microcosmic perturbation or iteration or sensitive dependence on initial conditions — non-linearity — leading to macrocosmic adaptation; bifurcations or punctuated equilibria presenting opportunities for system choice of developmental trajectories or parallel universes; and, genetic randomness efficiently short-circuiting the evolutionary process or natural selection into pathways of adaptation) allow for system robustness and an ability to adapt to dynamic environments via the creative, innovative, and learning possibilities that these very attributes foster. Furthermore, a holistic system's most innovative creations often are generated at the peripheries of the system rather than at the center or in the mainstream.

9) Adaptation to non-linear, relational, holistic environments renders a certain plasticity to the functionality of particular attributes. In different contexts, both historical and environmental, similar attributes take on sometimes radically different functions. Attribute definition, like the formulation of laws, takes on a relativistic, dynamic, open-ended quality contingent on overall system-wide context.

10) Both open-ended adaptation and non-linearity mean that, although a degree of determinism is always systemically present, system states and projections always have more than one solution, again lending holistic systems creative learning potentialities and choice or indeterminacy.

11) Causality, too, is holistically relational, and moves well beyond the Newtonian "billiard ball" variety. Causality also has nonlocal dimensions of infinite degree and distance, and, thereby, operates in the context of a deep connectivity. There are no clear-cut dependent and independent variables as such.

12) Holistic systems are characterized by profound cooperation and coevolution both between the "parts" themselves and the "parts" and the "whole". They are irreducibly ecological phenomena. Individual elements, therefore, are not discrete entities, but explicate forms of the implicate whole. Individualism, then, is a holistic, collective configuration, as the autopoetic paradox demonstrates.

13) Repeatable, empirically confirmatory experimentation has severe limitations in the holistic paradigm and is replaced by both qualitative, topographical mathematical mapping and intuitive system probing. The experimental emphasis is put upon accessing whole system movement rather than just the constitution or movement of its parts. This creative-experimental, insightful science of holism articulates a methodological pluralism within its paradigmatic parameters.

14) Non-linear, holistic systems are time-irreversible, and, once again, are thereby contingent, unpredictable and indeterminate.

15) Non-linear, holistic systems are self-referential, self-organizing, self-developing, and self-renewing.

Understandably, perhaps, the listing above may well leave some readers still a little unsure about some aspects of the new sciences, and only an immersion in the kind of literature cited in footnote #9 can ultimately do justice to the kind of scientific world view I am trying to articulate and promote in this paper. Nevertheless, even an "incomplete" understanding of what has been said above should alert the reader to the truly radical challenges which the N-C version of scientific methodology has been and is undergoing today in the natural sciences alone. Moreover, the radical challenges are such quite often because they turn many N-C scientific postulates a full 180 degrees around, thereby scientifically credentialling their former dialectical antitheses and/or rehabilitating formerly non-scientific methodological enterprises, like history, dialectical Marxism, and idiographic case studies, among many others, as quintessentially scientific ones. A true revolution, indeed!

But, perhaps a more useful way to proceed at this point would be to see how the new methodologies of the new sciences apply in some rather more concrete social scientific instances; lets do some applications, in other words.[11] Accordingly, in **Section III**, the bulk of the paper, I will take up the question of the study of history as a holistic science, including historical development (or trajectory), contingency, and "progress," among other related issues.[12] [13]

III

It has often been debated, of course, whether **history** is or is not, should or should not be, part of the social sciences, with no clear resolution either way. But, even if history has kept a place within the social sciences, under the N-C-positivist hegemony that place has certainly been none-too-well assured; indeed, the more N-C-positivistic a social scientific discipline has become the less historically oriented it has tended to remain, the historical idiographic dimension being slighted by and subsumed under the inimitable search for universalistic laws of motion or behavior (the nomothetic dimension). It is telling, I feel, that most introductory American Government courses only really deal extensively with history in order to get at America's constitutional foundations; the colonial period, the nineteenth century, and even a large part of the twentieth, are quite often omitted from a political scientific consideration or explanation of contemporary politics which becomes, consequently, completely disembodied from its historically and socially constituted contexts. Likewise in the discipline of economics, where positivistic-quantitative econometrics displaces the inclusion of history quite brazenly and even joyfully. If an economics curriculum has any space left over after the econometric foundations have been taken care of, then even the still rather abstract "history of economic thought" has priority over "economic history" *per se*. Model building, no matter how detached from reality the models may actually be, is deemed much more important, certainly much more scientific, than "story telling" by the high priests of the science of economics.

Of course, N-C-positivistic hegemony within the social sciences has had an enormous amount to do with all of this. After all, machines do not have variable, contingent history as such; if they have any history, then it is nothing more than the mechanistic repetition of cycles of predictable behavior according to deterministic, universal laws of motion — history is an equilibrium-seeking, stabilizing dynamic at best, not a dynamic of indeterminism, historical contingency, adaptability, plasticity, nonlinearity, and fundamental change. Ironically, although it has been N-C-positivism's claim to scientific fame to be the queen of rigorous empiricism, it seems to me, rather, that it has become

metaphorically and ideologically imprisoned within its metaphysical mechanistic world view and not liberated from paradigmatic narrowness or blindness by its so-called ascription to a most resolute reference to objective reality. Despite overwhelming empirical evidence to the contrary, the diehard N-C-positivists cling to the machine, their metaphorical haven of self-induced certainty and disciplinary comfort, while reality's turbulence and indeterminism swirl all around them. While certain parts of nature may well be machine-like, human beings in human societies clearly are not; in this fundamental sense, then, to insist that the mechanistic metaphor is most apropos for social science seems somewhat fatuous. It seems to me that empirical evidence alone forces one to agree with the conclusion of Nicolis and Prigogine (1989, 36, 66, 238) that:

[C]omplexity is concerned with systems in which evolution, and hence history, plays or has played an important role in the observed behavior... [For example,] a real-world system never stays in a single state as time varies... [M]ost systems are in contact with a complex or even unpredictable environment that continuously communicates to them slight...quantities of matter, momentum, or energy... [Indeed, our] everyday experience teaches us that adaptability and plasticity of behavior, two basic features of nonlinear dynamical systems capable of performing transitions in far-from-equilibrium conditions, rank among the most conspicuous characteristics of human societies. It is therefore natural to expect that dynamical models allowing for evolution and change should be the most adequate ones for social systems. (See also Masters 1989, 71, 112-113; Jantsch 1980, 255.)

The processes of evolution and change, transitions in chaotic (i.e. stochastic) conditions, of course, are articulated much more legitimately by the metaphors of the "new" sciences than they are by that of the machine. As a result, history and the historical dimension are rehabilitated quite fundamentally as quintessential elements not only of the social sciences but also of the natural sciences; living, adaptive, non-linear systems, both social and natural (if one, indeed, still wishes to uphold the dichotomy)[14], are inherently and intrinsically historical phenomena and, as such, their histories describe their movements and their trajectories and are, in part at least, explained by them.

Much historiographical blood has been spilt over whether history has any plan, meaning, or deterministic trajectory, whether it is open-ended or rule-governed. Overall, I think, the "new" sciences say "yes" and "no"; or rather, from some perspectives, they deny the dichotomy here, insisting that there is a dialectical union between determinism and indeterminism in the unfolding of the historical record. In the holistic universe articulated by the paradigm of the "new" sciences, there is "a remarkable cooperation between chance and determinism, one that is reminiscent of the duality of mutation (chance) and natural selection (determinism)" in evolutionary theory and, indeed, in the dynamics of stochastic non-linearity and complexity. As Cronin (1991, 16-17) says about evolutionary theory in this context:

Darwinism explains adaptation [and, therefore, historical trajectory] by cumulative selection: small, undirected variations that are channelled by selective pressures, resulting after long periods of time, in vast, complex, diverse and, above all, adaptive changes... [A]daptation [is] the successful incorporation of information about the world... The small changes that provide the raw materials for adaptation are undirected, random relative to the organism's environment. But the selective forces that shape these variations into adaptations carry vital information...about that environment ... The control that natural selection exercises over random variations is... like an engineer's idea of negative feedback: constant comparison between the representation of the world and

new information coming in from it, and constant adjustment and readjustment in the light of that comparison. The end result, adaptation, simulates deliberate, conscious design... [It is] design-without-a-designer.

And as Nicolis and Prigogine (1989, 14) say about holistic systems in general:

Far from equilibrium...[a holistic] system can adjust to its environment in several different ways... several solutions are possible for the same parameter values. Chance alone will decide which of these solutions will be realized. The fact that only one among many possibilities occurred gives the system a historical dimension, some sort of "memory" of a past event that took place at a critical moment and which will affect its further evolution. (See also Ruelle 1991, 90.)

This chance-determinism dialectic here can be illustrated by reference to the historical record itself in order to show both its theoretical and empirical applicability. The first example is the outbreak of World War One (cf. King 1991a). It is clear to me that the mechanistic concept of linear change and predictability is of limited use in trying to explain or even describe this particular historical incident; its relatively abrupt nature seems to defy explanation in terms of accumulative, law-governed development of the N-C-positivistic variety. Note, for instance, how the war was abruptly precipitated by one seemingly isolated and relatively small event (the assassination of the Archduke Ferdinand — a "perturbation", a phenomenon occasioned by "sensitive dependence on initial conditions", a "historical contingency"), an "event" which was "the straw that broke the camel's back" (a "bifurcation point", an "adaptation", a "cascading iteration"), that threw the apparently stable and predictable equilibral "balance-of-power" system (the so-called "Concert of Europe" alliance system designed to preserve the peace — a "self-equilibrating" phenomenon) into sudden and unpredictable disequilibrium, the chaos of "total war" (characterized by "turbulence", "uncertainty", and "spontaneity"). Note further that the very "stability" of the Concert of Europe had hidden or "enfolded" within its very dynamic and constitution the ingredients for the transition from peace to war, from stability to unpredictability, themselves; that although the war did indeed break out, it was only one possible "solution", selected from a parameter-driven menu of possible options (indeterminacy does not mean that any kind of solution is on the agenda), to the stresses that "perturbations" put upon the alliance system (the Kaiser and others had tested the parameters of the system several times before August 1914 without conflict erupting); that the complex and interrelated nature of the system contained the seeds of its own destruction, its inherent exponential "learning curve" eventually driving it to burst asunder its own parameter values; that the "memory" of 1914 greatly impacted subsequent system history after that year (cf. Briggs & Peat 1989, 145); and that the system "learned" its post-1914 behaviors not primarily as a result of "change" or "innovation" or "perturbation" at its center but in its relative periphery (the Balkans). All of this is compelling enough, it seems to me, to insist that we explore well beyond the N-C machine if we wish to more comprehensively come to grips with an understanding of the human historical record in all its complexity.

A similar analytical pattern emerges with an investigation of more recent events in the ex-USSR and Eastern Europe. Prior to, say, 1989 most "experts" on the region predicted no change in the foreseeable future, basing their extrapolations on the seemingly rigid, mechanistic stability of the Stalinist system and its ability to contain challenges to its integrity. To say the least, the collapse of Stalinism has been, to date, even more precipitous and unpredictable than the outbreak of World War One. Yet again, although the metaphor of the N-C machine lets us down in analyzing this phenomenon, the lan-

guage of the holistic paradigm speaks to us quite loudly. It could be argued, for instance, that what seemed a relatively small perturbation to the system, Gorbachev's hint that he would not use the Red Army to shore up Stalinism under threat and that he was in favor of some limited economic, if not essentially political, reform quickly and unpredictably cascaded with exponential iteration throughout the entire system, giving once peripheral voices (the people in the streets of Leipzig, for instance) the power to tear down the Stalinist citadel at its center. Gorbachev's perturbation, if you like, was the last in a historical line which pushed the Soviet system through a bifurcation point. But, again, the system's solution to this challenge was in no way deterministically assured — after all, more serious challenges, perhaps, than Gorbachev's had failed in the past to precipitate such a transition (e.g. Prague 1968), although, again, the chosen solution was indeed one that could in fact be selected from the system's parameter-driven menu of possible options; again, the complexity and holistic nature of Stalinism had carried the germs of its own terminal disease, a Gorbachev sneeze iterating exponentially into systemic pneumonia, a removal of one card bringing the whole house down; and again, no doubt, the "memory" of the coming down of the Berlin Wall will inform the history of the post-Stalinist era most fundamentally for some years to come.

Extrapolation in a mechanistic fashion from the historical record, then, while applicable in those breathing spaces in history when chaotic non-linearity is seemingly at bay, is fundamentally a very risky business, for we really cannot know for sure when those periods will come, how long they will stay, or when they will precipitously become chaotic. And while macro-history may give us fairly extensive breathing spaces, indeed decades or more, micro-level historical trajectories often do not. For instance,

> Economists [have] traditionally imagined that prices change smoothly — rapidly or slowly,...but smoothly in the sense that they pass through all the intervening levels on their way from one point to another. The image of motion [has been] borrowed from [Newtonian] physics...but it [is] wrong. Prices can change in instantaneous jumps, as swiftly as a piece of news can flash across a teletype wire and a thousand brokers can change their minds. A stock market strategy [is] doomed to fail...if it [is] assumed that a stock would have to sell for $50 at some point on its way down from $60 to $10 (Gleick 1987, 93).

And, although there may well not always be any immediate danger in extrapolating from macro-historical trajectory, the more the period of relatively stability persists at that level the less prepared we may become to accommodate to fundamental change when it does unexpectedly arrive, as, for instance, in former President Bush's inability to deal with post-Cold War conditions without resorting to inapplicable Cold War metaphors (good versus evil, fighting Hitlers to save democracy, etc.) in the recent Gulf War (cf. Nicolis & Prigogine 1989, 242).

To demonstrate, however, that historical trajectory is both non-linear and highly contingent, and all the rest, is emphatically not to say that history is not in some sense repeatable, at least in an allegorical or metaphorical way. Bifurcation points, for instance, do indeed offer multiple system solutions and the selection of any one will drive the system down a particular trajectory as opposed to some other. Yet, bifurcations also set up periodic and aperiodic oscillations such that, although the system switches from one state to another indeterministically, it will visit each state on more than one occasion, depending on the level of complexity, perhaps quite frequently. From the stochastic point of view, furthermore, historical trajectories and system states can be seen as "strange attractors", gravitating vortices of a generic historical behavior which the sys-

tem periodically returns to although never via exactly the same pathway or in precisely the same condition. Again, we find the continuity-discontinuity dialectic of holistic systems here: history both repeats itself and never repeats itself (see Briggs & Peat 1989, 108; Ruelle 1991, 88), historical events are both unique and contextually or environmentally articulated in some fundamental way (Briggs & Peat 1989, 154) as the "dynamical shifting web (150)" of historical trajectory moves on; and it was this very dialectic that one could argue characterized the Concert of Europe's sustainable, adaptive stability prior to 1914 and the Stalinist system's endurable, flexible rigidity prior to 1989.

Holistic systems, then, including human historical trajectory, are often maximally subjected to what, for all-intents-and-purposes, we might call "chance". The element of chance, although not an absolutely randomly-generated phenomenon, lends the historical record its uniqueness, its idiographic character determined by the contingent nature of historical, systemic development and change. Contingent determinism is post hoc or a posteriori determinism, that is, after the system choices have been made, the rest necessarily follows; after having made our beds, as it were, we must lie in them. A priori determinism, predictive certainty, struggles to establish itself in the holistic paradigm, for the system's initial conditions are a moving target, impossible to absolutely pin down. We do not know which train we are on, or where it is going, but it is relentlessly taking us there in any case as each junction in the track is encountered and we make our (limited, yet relatively open-ended) choices of which general way to go. Rewind the tape of life and play it again, as Stephen Jay Gould (1989) says, and we get a different story, and maximally so. Adapt to a slightly different environmental challenge the next time around and we fundamentally open up a whole new realm of developmental or evolutionary possibilities: take the challenge of heat stress away from Homo sapiens 100,000 years ago, as Ornstein says (1991), and the selection for upright posture no longer becomes maximally adaptive, de-selecting in the process our enhanced cerebral cortex, our extra-large brains, and the development of human civilization, culture, and language. Yet, amongst all this uncertainty, waywardness, accident, and contingency, everything that exists today and has existed in history is perfectly explainable, perfectly subject to some kind of deterministic cause.

The element of chance or accident in complex, non-linear, evolutionary theory is not only due to a holistic system's internal dynamic, its non-linearity; indeed, the maximal impact of chance can also be exogenously generated, quite often with absolutely spectacular, revolutionary results. The history of life on earth has been radically shaped and altered, its forms either dramatically enhanced and undermined, by the forces of "mass extinctions", exogenous events or impacts (meteors crashing into the earth's crust, for instance [Raup 1991, 170]) so momentous as to temporarily at least fundamentally disrupt the power and pervasiveness of adaptation and natural selection as the driving forces of life's evolution (183, 185). In a sense, episodes of mass extinction give the evolutionary process its greatest potential for creative adaptation, for innovative learning, if you will, despite their overriding of the "normal" articulation of natural selection. As Raup says, "many adaptive break-throughs - bursts of speciation accompanied by the origin of new families and orders - occur after the big mass extinctions... [The] principal role of extinction in evolution is to eliminate species and thereby to reduce biodiversity [or phylogenetic constraint, evolution's natural conservatism] so that space - ecological and geographical - is available for innovation (187)." Extinction's propensity for propagating wholesale innovation is reminiscent here of a number of similar episodes in human history, from the founding of new civilizations on the ashes of the

old (the eventual rise of a capitalistic, pluralistic north-western Europe from the remains of a decentralized feudalism), to the "Phoenix Factor" in Japan and Germany's meteoric rise to economic-industrial superpowerdom from the smoldering ruins of World War Two. The metaphor of the Phoenix is a most apt one in this context, a metaphor which has the deepest resonance with humanity's ancient absorption with the "myth" of new life and new possibilities being born of the decaying fibers of death and destruction themselves (see Weart 1988, ch. 1). But, it is equally as important here to remember that the beneficiaries of this learning, creativity, and innovation are not necessarily their engineers or their "natural" recipients. Both survivors and victims of mass extinctions are serendipitous phenomena, both equally subject to the roll of evolution's wanton dice (Raup 1991, 189-191).

This discussion of the role of mass extinction once again reminds us that the evolutionary process is emphatically not tied into a notion of linear progress, that later, more complex structures and processes are not necessarily "better" than earlier, simpler ones in any evaluative sense (see, for instance, Masters 1989, 209). Evolution and the historical trajectory are, if you like, a-directional and amoral; evolutionary adaptation and fitness as well as historical change and accommodation are temporary, incomplete, and suboptimal solutions subject to their own unintended consequences and those of life's essential serendipity, quasi-solutions to life's continual and unexpected challenges and stresses, stop-gap measures that make life and human civilization at least minimally sustainable until the next evolutionary puzzle is posed, until the rules of the game are changed once again in some fundamental fashion (see Raup 1991, 188, 191). At least two major social scientific lessons emerge from this assessment. First, evolutionary survival (winning the Cold War or being a hegemonic power in general) is no justification for either heralding or trying to maintain the status quo as some sort of ideological triumph or absolutely "proven" cause célèbre ; indeed, as was argued above, a celebration of the status quo tends to freeze learning and adaptation making any system or organism more, not less, prone to evolutionary challenge, if not outright extinction. Second, neither revolutions nor hegemonic triumphs can ever usher in "the end of history" (see Jantsch 1980, 255), as Fukuyama (1992), Marx, and others have liked to believe; again, at best, they are temporary solutions to the ongoing historical puzzle, and their erstwhile evolutionary fitness all too often eventually falls foul of the hubris of their own non-adaptive ideological straitjackets.

Survival, no matter how long or sustained, then, is still no proof of superiority or better fitness from an evolutionary perspective; both winners and losers, the living and the dead, the extant and the extinct, are determined by the whims of evolution's grim reaper (see, for instance, Gould 1989, 236; Masters 1989, 112). In fact, according to Gould, species survival may even represent a degradation or diminution of life's complexity, richness, and diversity, and not their enhancer, a characteristic he refers to as evolution's "bottom-heavy signature", a reversal of the orthodox cone of life (the pyramid) in which possibility and sophistication expand with the forward march of time. For Gould, this bottom-heavy signature is "a general statement about the nature of evolutionary diversification", viz., "early experimentation" followed by "later standardization", and although the "number of species may continue to increase, and may reach maximal values late in the history of lineages,.. these profound diversifications occur within restricted anatomies - nearly a million described species of modern insects, but only three basic arthropod designs today, compared with more than twenty [at the time of the Cambrian explosion some 600,000,000 years ago] (304; see also 47)." In short, survival

in terms of quantity comes at the expense of evolutionary quality, numerical success enforcing a convergence of adaptive design and a diminution of qualitative diversity that, like the genetic standardization of food crops (see, for instance Diamond 1992, 188-190), may well leave an organism or a system dangerously maladaptive in the long run, perhaps terminally so.

One can see here a social scientific parallel, perhaps, in the historical development of the world capitalist system: a fundamental capitalist hegemony forcing a global convergence around its basic civilizational signature, wherein earlier qualitative civilizational-cultural diversity around the world has been replaced by the quantitative success of a growing number of capitalist countries (species) of some variability (different mixes of the state-versus-market equation), but heavily qualified and structurally (anatomically) constrained by the underlying capitalist code of operation (see, for instance, Wallerstein 1974-1989). One wonders, indeed, what the fuller fruition of the world capitalist system might bring from an evolutionary perspective; if success breeds success, as Cronin's "bullies" do, then capitalist triumph may face **itself** as the next fundamental historical-evolutionary challenge where the "costs will be greater and victory less assured (1991,314)." And, as Gould (1989, 235) adds in a similar vein, evolutionary success always leads to more "stringent competition" between the incorporators of the triumphant design, which must by itself eventually result in "decimation" (increased strife between not only the USA, Germany and Japan and their respective emerging trading blocs, but also between them and a growing number of newcomers, the Asian NICs or "mini-dragons, and those countries, indeed, that are frustratedly left behind, the so-called Third World), since it is literally impossible for all the world to be capitalist success stories in a capitalist, ecologically constrained, universe. Capitalism, indeed, may well get its "dog eat dog" world yet, but not quite in the way its foremost apologists have assumed; extinction rather than progress may be the solution to this epochal struggle.

But, once again from a complex, non-linear, evolutionary perspective, the presumed eventual demise of the world capitalist system is certainly not all loss, since from the cataclysm of capitalist internecine warfare may well emerge a new, more qualitatively diverse, more experimental and adaptive, civilizational agenda; as Gould would say, the historical trajectory could return once more to "barrel filling (235)", that is, to making the most multi-faceted use of the civilizational space opened up by the cataclysm-causing relatively clean historical slate, much in the way perhaps Marx's "stages" of history have followed, or were supposed to follow, one after the other. And, once again, it is highly likely therefore that in the adaptive openness of this new environment, absent of phylogenetic-structural constraint as it would be, the pluralism and the "egalitarianism" of relatively unbounded opportunity would see adaptive creativity and innovation being fashioned in the peripheries rather than at the center of the old order, just as in history, in politics, and in science they are engendered by the civilizational backwaters and outposts, the minorities and dispossessed, and the mavericks and nonconformists, respectively, rather than in the imperial palaces, the government bureaucracies, or the institutionally-supported laboratories.

Yet, evolution also just as readily tells us not to get too excited or too optimistic about a new round of barrel-filling opportunity, or even about the creative-innovative potential of evolutionary open-endedness in general. Creativity, although necessary for long term survival and inherent in the evolutionary process itself, is nonetheless not a sufficient condition to ensure that only "good" things will happen; as history has

repeatedly shown, creativity has spawned just as much evil as beneficence. Evolutionary serendipity leaves the consequences of innovative adaptation highly contingent upon an essentially unknowable future, such that nature, history, and, indeed, *Homo sapiens* do not know what they creatively select for; we take continual leaps into the darkness, and whether our creativity is our parachute or a veritable millstone around our necks, we cannot know. As Schmookler (1984) has written, whether by design or force of circumstance or a combination of both, when humankind embarked on the road to civilization 200,000 years or so ago, it essentially selected for "power" as the bedrock of that development. This selection for power contextualized in the contemporaneous development of the culture-promoting human brain, with its relatively open-ended innovative capacities, embroiled *Homo sapiens* not so much in a new realm of positive freedom as in a fateful trajectory ravaged by ecologically destructive, and even genocidal, struggle.

Just as the freedom from the regime of nature brought upon mankind a new bondage to power, so also did the open-endedness of possibilities prove not a release from but a part of the [selective] trap. Because the process of cultural innovation is open-ended, there can be no end point in the maximization of power... The reign of power has no limit (24; see also Diamond 1992, 233; Harth 1990, 3, 36, 139).

Accordingly, as Capra (1982, 299-300) says, the "evolution of [human] consciousness has given us not only the Cheops Pyramid, the Brandenburg Concerto, and the Theory of Relativity, but also the burning of witches, the Holocaust, and the bombing of Hiroshima." A Faustian selection, indeed; but one like capitalism's in the global arena that is perhaps fated for self-imploding extinction.

And yet, in the brief twinkling of the geological eye that has been the last three hundred years or so of capitalism's rise to global hegemony, it is arguable that there has been and still is a significant degree of evolutionary adaptiveness on the part of liberal-democratic capitalism vis-á-vis human civilization, despite the litany of horrors listed above. (It is worth reminding ourselves here that adaptation always incurs both costs as well as benefits.) Liberal-democratic capitalism's relative degree of openness is conducive to and paralleled by that of the evolutionary process itself. In a very important sense, as Dyson says, the so-called "winning of the Cold War" was much less to do with the enlightened leadership, resilience, and resolve of the Reagan-Bush presidencies, and perhaps much more to do with the very dynamics and demands of evolutionary adaptiveness itself.

The open-market economy and the culturally open society, notwithstanding all their failures and deficiencies, seem to possess a robustness which centrally planned economies and culturally closed societies [like the ex-Soviet Union] lack. The homeostasis provided by a unified five-year economic plan and by unified political control of culture does not lead to a greater stability of economies and cultures... [T]he simple homeostatic mechanisms of centralized control have generally proved more brittle and less able to cope with historical shocks than the complex homeostatic mechanisms of the open market and the uncensored press... [Indeed,] Error tolerance [incorporated in openness] is the hallmark of natural ecological communities, of free market economies and of open societies (1988, 91-92).

And, as Masters (1989, 245) adds:

In politics and ethics...one is forced to judge individual events and to choose specific courses of action before knowing their outcomes. In social life, therefore, the plu-

rality of modes of cognition is a desirable and necessary way of gaining information in an uncertain world... The democratic political processes associated with republican or constitutional forms of government, like the informal decisions in hunter-gatherer bands and other face-to-face groups, are "naturally right" or healthy for human societies...[Furthermore, f]rom an evolutionary perspective, the balance of voice and voluntary exit characteristic of hominid bands prior to the development of large-scale agriculture is more closely approximated in the constitutional democracies of the West than in autocratic or totalitarian regimes. By maintaining avenues for widespread social and political participation and by restricting coercive exit to specified legal procedures of a public nature, societies ruled by law provide the benefits of a highly industrial civilization without the costs of more repressive societies. In contrast, highly authoritarian or totalitarian regimes seem to prevent large sectors of the population from engaging in behaviors [exit, voice and loyalty] typical of the human social repertoire...[In short,] evolutionary biology is [not] totally irrelevant to the preference for political freedom on which Western constitutional government is based. Modern biology provides grounds for understanding the widely shared hostility to institutionalized forms of coercive ostracism (222-223, 226).

Dyson's and Masters' arguments, of course, may be nothing more than natural science coming to an apologetic and perhaps inappropriate defense of the political-ideological status quo, yet the historical record alone seems to lend more than a minimal amount of grist to their argumentative mills: the Soviet bloc did fail, and failed tragically and disastrously, and it is in general trying at least to adapt itself to a more liberal-democratic, capitalist modus vivendi. Furthermore, it is worth bearing in mind that deeming something evolutionarily adaptive invokes no necessary normative evaluation of any particular kind; contrary to popular sociological belief, the theoretical claims and the empirical evidence of evolutionary biology know no political task-master (see Degler 1991), as we shall see directly below.

Still, although Dyson and Masters may well be on the right track with regard to the symbiosis between evolutionary dynamics and the liberal-democratic capitalist ensemble of institutions, values, and processes, they still, as Jantsch points out, put something of an idealistic gloss on the contemporary actuality of this civilizational structure. By drawing on the very same analytical methods of Dyson and Masters, Jantsch articulates the following powerful and insightful account:

[In] a control hierarchy [modern bureaucracy] the higher levels have to oscillate at lower frequencies than the lower levels which they control. Therefore, in the control hierarchies of Western democracy, the cultural ceiling is deliberately held rigid, as mobile as the social structures at medium or lower levels may have become. Social change is permitted only in the framework of unchangeable "values of society" and the latter's depositories, the institutions of society, are supposed to be preserved forever and without change. In an alive, multilevel reality, however, the issue should be to keep precisely the highest level open toward novelty (1980, 259)...[Furthermore, i]n combination with the short-range orientation towards elections - oscillations with a period of mostly not more than four or five years - [political] bargaining in small steps results in the stabilization and rigidification of structures, rather than in the catalytic furthering of their evolution (260)...[As a result, citizens] can no longer produce autonomous values, [and] have to be supplied with them. The activities which this requires increasingly block the social system. This kind of feedback which, from a certain point, leads to diminishing efficiency of social activity, has been aptly called "specific

counterproductivity...(261).

Clearly, the evolutionary adaptiveness of political democracy is no sure thing even after it may have been selected for; there is no free ride once we have boarded the train and it has left the station. Continued adaptiveness requires perpetual work and accommodation, even further evolution itself. As such, in terms of liberal-democracy, Jantsch advocates the following adaptive remedies:

Heads of government...should not simply be administrators, but the major agents and managers of openness and change...A democracy can only be creative if it admits and even furthers fluctuations. But this requires a new attitude toward the majority principle which basically is on the side of confirmation and meets novelty at best with distrust or even open hostility. Evolutionary creativity always renders invalid the "law of large numbers" and acts in an elitist way... Perhaps the most profound political paradox of our time lies in the need for "elitist" fluctuations to turn self-determinism into evolutionary self-transcendence [enlightened leadership acting solely in the public interest]... The only alternative is equilibrium ...of spiritual, social, and cultural death (270; see also Rosenau 1990, 288)...[Likewise in business and economic activity:] In process-oriented management, the role of manger [is to be a] catalyst... [engaged in] open-ended planning, [which has] no purpose teleologically, but is immanent in the process itself [and which leads to] no unambiguous, permanent solutions... Process planning in an evolutionary spirit ends the dualism between planner and planned, organism and environment, corporation and society, culture and nature (271-273).

In all, a fully-fledged evolution "is open not only with respect to its products, but also to the rules of the game it develops. The result of this openness is the self-transcendence of evolution in a 'meta-evolution', the evolution of evolutionary mechanisms and principles (8)." In like manner must a democracy "out-democratize" itself in a perpetual cycle of radical radicalism.

Political openness, of course, as denizens of a democracy too full well know, breeds perpetual political conflict, a state of affairs we often wish we could eradicate; indeed, a whole tradition of utopian political thought has made the building of political harmony one of its main focal points (see Kumar 1987). Not only is a degree of political conflict, however, seen to be healthy to an adaptive political system, it is also inherent in the evolutionary process itself, and is therefore quite a "natural" phenomenon, despite the risks it brings to political stability and even social decay. Political conflict, like most other adaptive traits, is a dialectical entity, having both good and bad points, benefits and costs, enfolded within its very dynamic. And all of this underlines the volatile nature of the human historical trajectory and the tendentious hold its various types of civilizational structure have and have had on permanency. With regard to the question of volatility, Masters concludes from his ethological study of M. Monax and its relevance to human society that: "The transient character of political communities during recorded history underlines the instability of very large societies, in which the subtle mixtures of competition and cooperation - well adapted for small groups - are easily destroyed...Precisely because the ambiguity [dialectic?] of cooperation and competition is natural to humans [in this way], it is never completely clear how we should relate to each other...[It] is rare that political institutions are universally acceptable and stable (1989, 21; see also 138)." And with reference to human civilizational sustainability, he asserts: "Governments and bureaucracies could emerge only when circumstances made a political system controlling large populations of nonkin consistent with the needs of humans formerly living in less centralized communities. Similarly, the conditions

under which states disintegrate is an empirical question about the environmental conditions under which decentralized, fluctuating political authorities are adaptive for human populations (112)." Again, as long as the universe remains holistic and dynamic, there can be no end of history, utopian harmony and perfection, a final solution to the puzzle of evolution and historical trajectory.

IV

Hopefully I have presented enough here concerning the nature and the applicability of the new sciences of holism for the social sciences to substantiate at least a reasonably compelling argument that they will come to provide the roots of a twenty-first century social science; a social science that will be much more pluralistic and open-ended, and thereby "richer," than our currently N-C-positivistically inspired one, but which will be nonetheless just as rigorous, empirical, explanatory, and scientific, indeed even more so, affording social scientists of all disciplines the new-found methodological freedom of the expanded horizons of a scientifically grounded holism.

Notes

1. Scott Gordon in his monumental, *The History and Philosophy of Social Science* (1991), has chronicled in some detail the long history of the borrowing of Newtonian methodology and world-view by a whole litany of "social scientists", from Hobbes in the C17th, through Comte in the early C19th, to Huntington in the C20th: "[A] listing of early social scientists who aimed to follow the epistemological footsteps of classical astronomy and physics is almost identical to a complete roster of the important names, and only moderately smaller is the number who explicitly described themselves as the Galileos or Newtons of social science (302)."

2. Whether the social sciences can and/or ought to adopt the world view and overarching methodology of the natural sciences is obviously a subject of great debate among both natural and social scientists. Unfortunately, I cannot really deal with that issue in any significant depth here; it requires a separate paper all to itself (but see King 1994, Chs. 1 & 2). Nevertheless, I believe that the holistic nature of the new sciences strongly suggest that at least in some areas of the social sciences the adoption of the "natural" science methodology of the holistic sciences is indeed appropriate, legitimate, and relevant. (See also note #12 below.)

3. When I use the word "method", "methodology", or "methodological" I can mean a variety of related things — research method, epistemology, metaphysics, gestalt — depending on the context, and, indeed, I hope context will enable the reader to assess exactly what is being conveyed at any particular time.

4. See for instance, Capra (1983, 1991); Herbert (1985).

5. See for instance, Waldrop (1992); Kauffman (1993, 1995); Gould (1989).

6. See for instance, Masters (1989); Ball (1995).

7. Hereafter, the abbreviation "N-C" will be used for "Newtonian-Cartesian".

8. They are "new" to us, who have been metaphysically and methodologically blinded for the last three hundred years or so by N-C hegemony in the Western world which has systematically, and ideologically even, denied their (the "new" sciences) existence or at least relevance. However, they are not literally new, the ideas and methods encapsulated within them having been part of the human intellectual record

from our species' very beginnings in one form or another, whether in religious myth or philosophical schema or scientific method. See for instance, Capra (1983,1991); Briggs & Peat (1989).

9. See for instance, Bateson 1972; Bohm 1980; Briggs & Peat 1989; Capra 1983, 1991; Davies & Gribbin 1992; Gleick 1987; Gould 1989; Herbert 1985; Jantsch 1980; King 1994; Masters 1989; Nicolis & Prigogine 1989; Prigogine & Stengers 1984; Waldrop 1992.

10.The listing here is drawn from King (1994, 95-98).

11. In response to the criticism of one of my reviewers, who lamented, in his or her view, my lack of specifically explaining "how to do" the new science from a narrowly construed definition of methodology, let me clarify the term "application" here. Application in the context of this article refers primarily to the application of metaphor or gestalt or world view, as opposed to a step-by-step practical guide to conducting empirical-quantitative research. Of course, at some point in the development of what I am calling the new, holistic scientific approach a guide of sorts or relative methodological specificity will become necessary. In the space limitations I have here, however, such a project is entirely unfeasible; indeed, it is an undertaking of many booklength proportions. It is also project I am working on in my next book whose title, "The Scientific Roots of Dialectical Thinking," should indicate to a philosophically discerning reader that the "methodology" of holistic science is more than just the mechanical following of a series of so-called practical steps; indeed, such a science looks to transcend mechanism and linearity in all of its forms, metaphysical, epistemological, and methodological. One might say, in fact, that the very idea of a dialectical-holistic methodology is to some degree an oxymoron, since, by denying mechanistic reductionism, it must by definition be, in essence, "anti-methodological" at least in the N-C positivistic sense (see, in this context, Ollman's "Dialectical Investigations," Feyerabend's "Against Method" and Warren's "Dialectical Theory"). In addition, it should not be assumed, it seems to me, that the much vaunted methodology of positivism or behaviorism is that much more, if at all, clear and specified or practically useful as a guide to research than the dialectical holism I am referring to above. It should not take any of us too much thought to recognize that the positivist command to measure and to operationalize in a quantitative manner, for instance, is fraught with difficulties (try "democracy" or "racism"), including those of a metaphysical or epistemological kind, and that most, if not all, so-called empirical research is plagued with problems of validity and reliability and the (in)appropriateness of statistical analysis. Of course, positivistic-behavioristic methods are and, at least in part, should be used, even by dialectical holists as my paper suggests; they do, after all, tell us "something" about the world. But, to hold dialectical holism up too strongly against a methodological standard that even positivistic-behavioralism cannot aspire to is both a straw man argument (akin to "the pot calling the kettle black"), and a misunderstanding of how different a science dialectical holism is, in that it apsires to transcend the mechanistic reductionism of N-C positivistic-behaviorism which itself undergirds its alleged step-by-step, mechanistic-reductionistic methodology in the first place.

12. There are in actual fact numerous other social scientific issues that are fundamentally affected by the kind of theoretical-methodological approach I am trying to articulate here, from atomistic ontology or methodological individualism, to social collectivities as social actors, to dialectical theory, to critical theory, to holism, among

many others. Space limitations here obviously mean that I can only reasonably effectively articulate one subset of such questions; hence, quite arbitrarily, I have chosen to focus on the issue of historical change exclusively.

13. This overall project dealt with in brevis in this paper obviously requires a whole research program in order to turn it into the kind of revolutionary paradigm-shifting event I think it ought to and will be. Indeed, that research program has already begun in the last 10 years or so (see, in particular, Bateson 1972; Bohm 1980; Briggs & Peat 1989; Capra 1983, 1991; Davies & Gribbin 1992; Gleick 1987; Gould 1989; Herbert 1985; Jantsch 1980; King 1994; Masters 1989; Nicolis & Prigogine 1989; Prigogine & Stengers 1984; Waldrop 1992). Obviously, all I can do in a relatively short piece like this paper is to "sound the herald", and hopefully enough interest will be generated among its readers for them to pursue the topic further, and, perhaps, to help to develop the holistic science research program in the process.

14. A most telling conclusion of my research into the relationship between natural science methodology and its applicability to the social sciences is that, at least under the rubric of chaotic, non-linear, evolutionary complex "living" systems, there is no essential or necessary difference between the subject matter of the natural sciences and that of the social sciences, nor in how to study the phenomena contained therein. **Wherever** contingency, non-linearity, and evolutionary processes actually describe either elemental behavior and/or systemic dynamics, and these are displayed in a multitude of both "living" natural-physical and social settings, then the natural and the social sciences can indeed share metaphysical, epistemological, and methodological characteristics and assumptions. Of course, this is **not** to claim that **all** natural scientific methods are applicable to the social sciences, only those that are articulated by the new sciences.

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