Two Millennia of *Natura non Facit Saltum* is Enough

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Abstract

The concept of uniformity has its roots in Classical Greek philosophy, but its importance for 20th century science derives largely from the works of Newton and Leibniz. The methodological version of uniformitarianism that appears in Newton's Principia has been accepted in principle by all of the historical and nonhistorical sciences. The substantive version, which is embodied in Leibniz's maxim "Nature makes no leaps" and which is irreconcilable with the methodological version, has not been of central importance in the nonhistorical sciences, but has alternately advanced and retarded the development of the historical sciences. This paper explores some aspects of the history of the concept of uniformity, and discusses the development of the historical sciences with regard to their acceptance or rejection of Leibniz's maxim. It argues that sociohistory may be intrinsically capricious, and that any theory of sociohistory that rules out "leaps of nature" probably is fatally flawed.

Keywords

Uniformitarianism, catastrophism, gradualism, punctuated equilibria, evolutionism

The Problem of Uniformity in Historical Sciences

There is a paradox in the study of large-scale, cumulative, irreversible change in all of the historical sciences, including astrohistory, geohistory, biohistory and sociohistory. To work backwards in time from the known present to the unknown past, we must assume that the principles underlying the structure and operation of the universe in the past were the same as those of the present. If that methodological assumption is disallowed, we cannot infer or extrapolate temporally and the past is intrinsically unknowable. At the same time, however, one of the most important substantive questions that we can ask about the nature of the universe is whether there have been cumulative changes through time in the principles underlying its structure and operation. If that possibility is disallowed, the postulate of the invariance of natural law is a trivial tautology. A science of history is difficult; a science without history is parochial.

Although the paradox manifests itself in all of the historical sciences, this paper deals primarily with its expression in human sociohistory. For purposes of the paper, I define sociohistory as a) the study of the structure and operation of societies synchronically, and of changes in their structure and operation that occur diachronically, and b) the subject of that study. Sociohistory thus conceived encompasses the disciplines and the subject matter of most of the social and behavioral sciences and several of the humanities, and overlaps extensively with biohistory conceived equally broadly (Simpson 1963). It simultaneously views human history in two different ways: firstly as the large-scale natural history of our species, and secondly as the chronological sequence of events that has occurred in the larger context of our natural history.

Although the concept of evolution has fundamentally different meanings when it is used in disciplines as diverse as cosmology, paleontology, biology and anthropology, it nevertheless has been applied loosely to certain aspects of human history for so long that trying to avoid it seems to be more trouble than it is worth at this point. Suffice it to say that this paper examines general problems of tempo and mode (Simpson 1944) in human biosocial evolution, but does so with the understanding that the concept of evolution as it applies to human history is itself problematic.

Specifically, the paper joins the fray over continuous and discontinuous models of historical change. First it examines some aspects of the history of the competing models as a corrective to the historical shallowness and disciplinary narrowness of the current controversy about these models in sociohistory and biohistory. Then it discusses ways in which the distinctive world view provided by each model shapes research and speculation in sociohistory.

I am interested in the “forest” - human history in the broadest sense - and deliberately disregard the multitude of disciplinary boundaries that tend to isolate the “trees” (or even the “twigs”) from each other. The paper contains a number of broad generalizations that do not apply equally to every discipline on which the discussion touches, but local exceptions do not necessarily invalidate the generalizations.

I limit the scope and length of the essay by discussing representative people and ideas rather than attempting to be encyclopedic, and confine my remarks to mainstream participants in the Western intellectual tradition.

A Ravel of Roots

Writing historical accounts of the debate between uniformitarians and catastrophists (the U-C debate) has become something of a cottage industry in recent decades, and this section of the essay is offered as a contribution to that tradition. It contains a broad-stroke summary of much that has been said by others, combined with attempts to insert some crucial missing pieces especially with regard to roles that people such as Newton and Leibniz played in setting the stage for the current U-C controversy in biohistory and sociohistory. Because it is avowedly a broad-stroke summary, it will offend specialists who want to know more and more about less and less.

Concerning the nature of God, Classical Greek philosophers reached no consensus on the fine points, but generally agreed that God was remote from the world of human actions. Variously presented by Plato, Aristotle, their predecessors and contemporaries as prime mover, unmoved mover, first cause, final cause, and personification of the Good, God either put our world into operation and withdrew from it, or coexisted with our world and affected events occurring in it from afar. By contrast, the early Judeo-Christian God was an active divine being who intervened intermittently in people's lives and in the operation of the universe at large thus giving the universe a more capricious aspect than that of the Greek philosophers.

Concerning the nature of time, Greek philosophers advocated at least two important alternatives. Aristotle postulated an eternal universe, a dynamic steady-state system without beginning or ending in which time *per se* was of local importance only, while Plato accepted the common Greek notion of time as a series of world cycles, each having a beginning and ending, each being a reiteration of events that had recurred since God produced order from chaos at some unknown time in the remote past. From both perspectives, time was essentially unbounded and enduring.

On the other hand, time in the early Judeo-Christian tradition had a specific beginning that coincided with God's creation of the world, a midpoint marked by the birth, death and resurrection of Jesus Christ, and a certain and imminent ending to be announced by the second coming of Christ. Once again, caprice was alien to many Greek philosophers, but was an integral part of the early Judeo-Christian tradition.

Concerning the physical structure of the cosmos, there was only minor disagreement within and between Greek and Hebrew traditions. Earth-centered Greek models of the universe, postulated by Pythagoras, enhanced by Aristotle, later renovated extensively by Ptolemy, were compatible with the vaguely delineated Old Testament cosmos, and the twin notions of eternal stars and perfect circles became powerful ingredients in Western cosmologies.

Concerning the nature of being, the situation was more complex. In his classic study of the Chain of Being, Lovejoy (1936) discusses at great length three principles introduced in the works of Plato and Aristotle that came to dominate Western ontology. They are the principles of plentitude, continuity, and unilinear gradation. They have no clear parallels in the Old Testament.

The principle of plentitude asserts that the connection between Plato's worlds of Being and Becoming is perfect. "If any eternal essences have temporal counterparts, the presumption is that all do ... If it were not so, the connection of the two worlds would seem to be unintelligible, the constitution of the cosmos ... a haphazard and arbitrary thing" (Lovejoy 1936:52). In other words, the principle of plentitude rules out capricious "gaps" in the relationship between the eternal and unchanging world of essences and our own ever-changing and contingent world of accidents.

The principle of continuity asserts that things are continuous whenever there is one and the same limit of both wherein they overlap and which they share in common (Lovejoy 1936:55). Aristotle makes this argument specifically with regard to quantitative matters such as lines, surfaces, solids and motions, and does not assert that qualitative differences yield the same kind of continua, or that only one such continuum exists. Nevertheless, he notes that any division of living creatures with regard to one determinate attribute gives rise to one linear series of classes whose boundaries are indistinct, and furthermore that all things can be graded or ordered according to the degree to which they realize all of their potentialities or approximate the good (Ross 1923:179). This single exceptionally important ontological order is what Lovejoy (1936:59) calls the principle of unilinear gradation. These principles characterize a universe from which caprice is absent.

Concerning the nature of change, especially in human social organization, Nisbet (1969, 1980) argues that Greek literature and philosophy relied primarily on the metaphor of growth. The primordial human condition was one of technological and social simplicity, followed by later stages of development displaying increases in complexity: families grew or merged to form villages which grew or merged to form cities and states. The metaphor of growth joined with the theory of world cycles to yield a scheme in which each cycle began with a Golden Age of simplicity and innocence, after which increases in knowledge, skills and social complexity yielded concomitant decreases in goodness and happiness. Each cycle then ended in decay and was followed by another cycle (Nisbet 1969:29-44).

While Old Testament stories of the Garden of Eden, the Fall, the Noachian Flood, and the Tower of Babel resemble the Greek notion of a Golden Age followed by degeneration, the Old Testament tradition differs sharply from the Greek in depicting the present cosmos somewhat more pessimistically as a unique creation within which Golden Ages do not recur. Furthermore, major changes in the social order that occur in the Old Testament rely primarily on God's intervention rather than on the operation of intrinsic processes.

The Medieval Christian synthesis of the ideas outlined above was a powerful but difficult achievement. From the Old and New Testaments it received the notion of a Divine Providence that could and did intervene in the ordinary operation of the universe whenever and however it suited him to do so, and the notion of a universe characterized by linear time with a known and recent beginning and an impending end. These are major components of a model of an intrinsically discontinuous and capricious universe.

From Greek ontology it derived the Chain of Being, a major component of an intrinsically continuous and non-capricious universe. In one of its guises, the Chain established a linear order among every class of beings with God at the top, less perfect supernatural beings next, then man, followed by mammals, birds, reptiles, fish, insects and so on down to the lowest of God's creations. As a biological taxonomy, the Chain was known as *scala naturae*, the Scale of Nature.

The Chain stretching downward from God was suggestive of Aristotle's geocentric cosmological model which was duly modified to accommodate Christian ideas of Heaven at the outer limit and Hell at the inner, and the Chain of Being was super-imposed on it. In this form the Chain came to be a dominant structural model of the universe.

Although ideas concerning spectacular Biblical events such as the creation, the flood, and the parting of the sea presupposed a capricious universe, other ideas concerning change were incorporated into the Chain of Being. To accommodate the Christian notion of attaining beatitude, the *scala naturae* was interpreted in part as a ladder by which people could ascend toward God and beatification, at least spiritually if not physically.

The resulting Medieval Christian model of the universe was tightly bounded in time and space and rigidly organized in accordance with the Chain of Being in its three major guises. For the most part, it was a short-term static structure whose mechanically repetitive, essentially non-cumulative operation was jolted occasionally by divine intervention. It was at the same time both a capricious and a non-capricious universe. Its integrity was enhanced by the pervasive belief, entailed by degenerationism, that knowledge about the cosmos was to be obtained by consulting Aristotle and the Scriptures rather than by using one's own senses and abilities to examine the cosmos directly.

Medieval Christian philosophers, theologians and their assorted followers were a highly disputatious lot, and the summary that I have presented probably would not have been accepted gracefully by any of them. But it is sufficient to set the stage for an equally broad-stroke summary of several major events that occurred during the next five centuries.

It is arguable that the so-called "scientific revolution" that became clearly visible in the 15th century was in part a series of attacks on the Medieval Christian model of the uni-

verse that is summarized above. One line of attack, which I call nonhistorical, focuses primarily on understanding the structure and operation of the universe and its components at the present time, and presupposes the existence of the universe in its present state. Another line of attack, which I call historical, focuses primarily on understanding cumulative changes in the structure and operation of the universe, and presupposes some knowledge of its present state. In the following paragraphs I use Newton and Leibniz as representatives of these two lines of attack because their works are early, clear, relevant and often overlooked in the U-C debate, not because I see the history of science as a conflict between these two giants and their Lilliputian descendants.

The archetypical nonhistorical attack yielded the rejection of the geocentric model of the cosmos, its replacement with the heliocentric model constructed by Copernicus, Kepler and Galileo, and the mathematical interpretation of the structure and operation of the heliocentric model by Newton. As an example of how the nonhistorical attack has been pursued, we can examine Newton's rules of reasoning in philosophy (Newton 1934:270-271), in which Newton's principles of simplicity and uniformity of nature are clearly stated.

First, Newton had to choose between a universe based on natural processes and one based on divine intervention. He opted for a naturalistic universe, asserting that a simple explanation is preferable to a complicated one, thereby ruling out the possibility of invoking God as an explanation of the day-to-day operation of the universe. This is his principle of simplicity.

Second, he had to choose between an intrinsically incomprehensible cosmos in which events happen capriciously and a potentially comprehensible cosmos in which the principles underlying its structure and operation, whatever they might be, do not vary capriciously. He opted for a comprehensible cosmos, asserting the principle of the identity of causes where effects are the same, subsequently known as the principle of the uniformity of nature.

Third, he had to choose between a universe in which knowledge is limited by one's own direct experiences and one in which it is possible to generalize or extrapolate from the known to the unknown. He opted for universality rather than particularity.

Fourth, he had to choose between a universe that was knowable primarily by means of experiment and induction and one that was knowable primarily by means of deduction from the works of the ancient authorities. He opted for experimentation and induction, arguing moreover that empiricism was to be the ultimate test of his first three principles.

The methodology that Newton's rules of reasoning entail may be interpreted from at least two perspectives (Burtt 1932:218-220).

On the one hand, they are a set of assumptions or postulates concerning the procedures whereby scientists should acquire new knowledge: do not invoke God; do not invoke caprice; do not assume particularity; experiment.

On the other hand, the first three constitute a null hypothesis concerning the nature of the universe: We should assume that the natural world works simply and uniformly until and unless empirical observations lead us to reject that hypothesis mathematically.

In accordance with his rules of reasoning, Newton conceived of natural laws as exact mathematical descriptions of how the universe works. Such laws were neither regulations promulgated by a deity nor metaphysical explanations of what the universe is or why it works the way it does. Newton's concept of natural law was fundamentally different from that of rationalists such as Descartes and Leibniz who were busily constructing other models of the universe on the basis of intuition, self-evident truths, and deduction from authority. More about rationalist laws of nature anon.

The historical attack emerged concurrently with the non-historical, but its subject matter and underlying assumptions were fundamentally different. Due to broadening intellectual, physical and cultural horizons that accompanied both the Renaissance voyages of exploration and the rediscovery of the Classics, two of the great problems that confronted 17th century social philosophers were synchronic cultural diversity and cumulative diachronic change in the human condition. Solutions offered by the medieval heritage were unsatisfactory on at least two counts: they presupposed pessimistic degenerationism in a period of rising optimism, and they were not expressed as "laws of nature" in a period of fervent belief in nature's lawfulness.

In the 19th century, Sainte-Pierre and others turned degenerationism on its head and also rejected the notion of a capricious deity who would or could bring the world to an end at any time, arguing instead that progress was intrinsic to the human condition and that the duration of the future in which human progress could continue was unknowable or indefinite (Bury 1920; Nisbet 1969, 1980; Teggart 1941). But the idea of progress, which soon was transformed into the Law of Progress, was a substantive assumption derived directly from Classical typological histories and from the Chain of Being conceived both as *scala naturae* and as a ladder by which to attain beatitude, and was incompatible with the view of science espoused by the likes of Newton. While the presumed impending end of the universe was irrelevant to the methodological and substantive issues confronted by early nonhistorical scientists, its explicit rejection by those who espoused the Law of Progress was vitally important for the emergence of the historical sciences.

In a sense, then, Cartesian rationalists won the battle to found the historical sciences just as Newtonian empiricists won the battle to found the nonhistorical sciences. Leibniz, in good Cartesian style, admirably summarized one of the major planks in the rationalist platform as follows: "It is one of my great maxims ... that nature makes no leaps (*Natura non facit saltum*), a maxim that I call the Law of Continuity" (Leibniz 1896:50; also 1896:552).

But herein lies a great confusion. The empiricist principle of uniformity was a methodological postulate and a testable null hypothesis, whereas the rationalist Law of Continuity (or Law of Uniformity as it came to be known) was a substantive assertion about the nature of the universe, an explanatory device and organizing principle to which data about the universe were required to conform. Furthermore, since Newton's principle was not a description of how the universe works, it was not stated as a natural law as was Leibniz's proposition.

In this context, then, the concept of uniformity had three fundamentally different meanings. To Newton and his ilk it meant a) that nature, if it were comprehensible, could not behave capriciously, and b) that we should begin our inquiries with the assumption that the universe is "innocent" (simple) until proven "guilty" (complex) by empirical means. To Leibniz and his ilk it meant c) that changes in nature necessarily occur gradually, that no "gaps" interrupt nature's intrinsically continuous gradations, and that empirical tests of this notion are impossible. All of these senses of the term have made far reaching contributions to the development of scientific thought, but they had the grave misfortune of becoming quite muddled early on.

The nonhistorical sciences have retained the methodological version of uniformity but have had no particular use for the substantive version. The ancient concept of perfect circles is only one of many superfluous substantive assumptions about the nature of the universe that fell quickly before the nonhistorical attack on the medieval worldview. On the other hand, the historical sciences have attempted to use both the methodological and the substantive versions of uniformitarianism despite the implicit contradictions that result.

The remainder of this essay deals exclusively with the historical sciences and their love-hate relationship with substantive uniformitarianism: the remainder of this section briefly examines some aspects of geohistory and biohistory from the perspective provided by the foregoing remarks, while the next section focuses exclusively and in greater detail on sociohistory.

The ambiguity of the concept of uniformity lay at the center of the 19th century U-C debate in geology. For example, Lyell accepted the methodological assumptions embodied in the Newtonian principles of simplicity and uniformity of nature, but also argued that the overall appearance of the world was essentially stable through time and that the observable processes that produced superficial changes in the earth's surface proceeded at a steady pace. These two latter assumptions, which Gould calls uniformity of configuration and rates, are based squarely on *Natura non facit saltum.* They underlie Lyell's belief in *scala naturae* and the fixity of biological species, and are thoroughly incompatible with the Newtonian principles.

The 19th century U-C debate in geology focused not on the methodological component of uniformitarianism, but on the substantive component. Specifically, the substantive assumptions that time was endless and that the present was the key to the past directly

contradicted the much older substantive assumption that the world was created by divine intervention in 4004 BC. It makes no difference that the age of the earth is now considered to be finite, that major events that happened early in earth history have no current counterparts, that in fact most or all of the substantive assumptions underlying the 19th century U-C debate were false at worst or of only limited applicability at best. If the uniformitarian geologists had not opted for a continuous model when they did, they might never have removed the boundary from the past. But the fact that the model based on a belief in substantive uniformitarianism was useful for a while clearly does not mean that it was generally valid.

Advocates of the Law of Progress in the 19th century focused on the future and rejected the proposition that the end was at hand. Uniformitarian geologists in the 19th century focused on the past and rejected the proposition that the beginning was recent. Together, they affected a change in the presumed temporal structure of the universe that was as radical as the change that Newton and his predecessors had wrought in its presumed physical structure, and the ambiguous concept of uniformity was central to all of these events.

The ontological problem addressed by the *scala naturae* and solved from that perspective by Linnaeus in the 19th century was reformulated when the windows of time opened. It ceased to be primarily a structural problem and instead became primarily a historical problem.

Darwin's solution to it had three major elements.

First, the Malthusian argument against infinite human progress in a world of finite resources (which Malthus had aimed directly at advocates of the Law of Progress), when combined with Darwin's own knowledge of intraspecific diversity, produced the nonhistorical notion of differential survival of contemporaneous organisms.

Second, observed heritability of characteristics by unknown means added a short term diachronic component to the notion of natural selection.

Third, the vast stretches of past time offered by the uniformitarian geologists, when combined with the first two elements, yielded a plausible interpretation of large scale configurational changes that appeared in the paleontological record.

Darwin took methodological uniformitarianism for granted, but also accepted substantive uniformitarianism in the form of the Idea of Progress and "that old canon of natural history, *Natura non tacit saltum*" (Darwin 1962:203, 469), both of which occur repeatedly in *The Origin of Species*. Leibniz's maxim made especially important contributions to Darwin's work with regard to gradualism, or uniformity of rate, and continuity, or the presumed absence of gaps in nature.

Substantive uniformitarianism facilitated the emergence of a naturalistic philosophy of biohistory in the 19th century and has proved invaluable in the study of small scale

evolutionary changes, but its relevance to the study of large scale changes for which Darwin originally invoked it is under serious attack. The punctuated equilibrium model that seems to be a viable competitor with the gradualistic model may eventually relegate biohistorical gradualism and continuity to the status of special cases, as has already happened in geohistory and as Einstein's theories of relativity relegated Newtonian mechanics to that status in cosmology. But the temporary utility of substantive assumptions does not argue for their validity.

Uniformity in Sociohistory

Although both methodological and substantive uniformitarianism have contributed importantly to the development of sociohistorical theorizing, I suspect that the substantive version has outlived its usefulness. In the remainder or this essay, I argue for its rejection as a common presupposition of sociohistorians.

Generally speaking, sociohistorians can approach problems of tempo and mode from at least three different perspectives.

The first is to accept methodological uniformitarianism and also to accept some form of Leibniz's great maxim *Natura non facit saltum*. On the basis of the substantive assumptions, one can argue that all major events in human sociohistory are manifestations of gradual and continuous change, that apparent discontinuities occur at the high end of a continuum defined strictly in terms of tempo or rate, and that the continuous-discontinuous dichotomy is an artifact of human perception and cognition rather than an indication of differences in modes, mechanisms and processes of change.

The second is to accept methodological uniformitarianism but reject the substantive form. This strategy admits the possibility that some changes in sociohistory may be continuous while others may be discontinuous, that differences between the two are natural rather than arbitrary, and that tempo may or may not have anything to do with the matter.

The third is to be ambivalent or at least ambiguous in this matter, switching opportunistically from one position to the other without regard to the confusion that ensues. This approach may sometimes be equivalent to ignoring the problem altogether.

In absolutely continuous models, changes within and between categories accumulate along one or several parallel, diverging or converging trajectories, all units of analysis (species, societies, stars) are locatable at discrete points on trajectories, and delimiters between stages are nothing more than boundary markers at arbitrarily selected points on the continuum.

In radically discontinuous models, differences and changes within categories are non-directional and non-cumulative variations on a common theme, units of analysis within each category cannot be ordered meaningfully relative to each other along continua defined by common themes, and transitions between categories occur at natural breaks with the past that cannot be predicted by analyses of past trends. Subsequent conditions are not intensifications or elaborations of antecedent conditions, but rather are new themes on which new sets of variations can develop, the new themes either replacing or subsuming the old ones.

The distinction here is based on presumed differences in mechanisms and processes underlying change. It is not based on rates of change; i.e., slow change in not necessarily continuous and fast change is not necessarily discontinuous. Nor is it based on products of change, for emergence presumably can occur by means of both continuous and discontinuous change, even though reductionist analysis can apply only to emergence by continuous means, not by discontinuous means. Yet no consensus has emerged concerning which events or kinds of events fall into the continuous and discontinuous classes, what descriptive criteria should be used to distinguish between the classes, what processes or mechanisms of change characterize each class or distinguish the classes from each other, or how events in the different classes are interrelated.

Nevertheless, continuous and discontinuous models may reflect basic differences in mechanisms and processes or change, each may be useful in conjunction with some but not all units of analysis and scale factors, and their forms may reflect important differences in the conditions and events that characterize stable periods and states.

One who argues that change is intrinsically continuous either implicitly or explicitly accepts both Lyell's famous dictum "the present is the key to the past", and its corollary "the present is the key to the future". One who argues that change need not be intrinsically continuous accepts the possibility that history may be filled with surprises and that the future behavior of the universe may be capricious and immune to prediction on empirical as well as logical grounds (Popper 1957).

As Nisbet (1980) and others have demonstrated, the metaphor of growth lies at the heart of continuous models in sociohistory. The overwhelming power that these models have wielded – and continue to wield – is apparent from even a cursory examination of the monographs and textbooks in the various fields of sociohistory that are sitting on your bookshelf. In anthropology, for example, it is fashionable now to dismiss the explicitly continuous and unilinear explanations embodied in the Grand Theories of Lewis Henry Morgan and his ilk in the 19th century. However, the organizational schemes and prime movers (if any) that characterized the Grand Theories came to us in large part from Plato's *Laws* and Aristotle's *Politics* and persist today with only minor modifications, many of which have been designed primarily to deflect criticism rather than to enhance understanding. If it looks like a duck and walks like a duck and sounds like a duck, it is at least reasonable to suspect that we are dealing with a duck.

Table I summarizes a broad sample of works that embody continuous models of sociohistorical change in various forms. All of them derive ultimately from the Greek metaphor of growth, and include ontogenetic models, ecological succession models, and phylogenetic or speciational models. (Synchronic structural-functional and steady-state ecosystem models, based on organic or organismic models that also derive from biological metaphors, are absent from the summary.) In each case, sociohistorical stages, levels, grades or classes are arranged from bottom to top in order of increasing size, complexity, sophistication or intellectual advancement, and the order bears some relationship to a chronological sequence.

A	***B***	***C***
Nation City Village Family	Civilization Upper Barbarism Middle Barbarism Lower Barbarism Upper Savagery middle Savagery Lower Savagery	Nation State Chiefdom Tribe Band Family
Plato 1961	Morgan 1964	Steward 1955:43-77,101-150; Service 1971, 1975
D	***E***	***F***
Irrigation agriculture Field crops Horticulture Shifting agriculture Casual agriculture No agriculture	Communist Capitalist Feudal Slave Tribal	Empire Florescence Formative Incipient agriculture Hunting-gathering
Murdock 1957 (Column 28)	Marx 1965	Steward 1955:178-209
G	***H***	***I***
Industrialization Urbanization Domestication Language acquisition Tool use	Grade V Grade IV Grade III Grade II Grade I	Multi-male troops Age-graded male troops One-male troops Parental families Solitary individuals
Childe 1942; White 1969	Crooke and Gartland 1966	Eisenberg et al. 1972

Table 1. Sociohistorical stage's, levels, grades, periods, classes, etc., arranged in order of increasing size, social or technological complexity, intellectual advancement, etc. Sources are cited beneath the scales.

Certainly the objectives and details of present day models differ from each other and from those embodied in the *Laws* and *Politics*. The models in Table I focus on humans, nonhuman primates, or both; they deal with subsistence, technology, economy, ideology and social organization; they were derived by direct generalization from historic and prehistoric data, inference from ethnographic data, regression analysis, or argument from *a priori* postulates; they are both "unilinear" and "multilinear". But the

hypothesized stages, their defining characteristics, and the underlying metaphor of growth have remained largely unchanged for 2500 years. To the best of my knowledge *Natura non tacit saltum* is not explicitly invoked in any of these works, but its spirit deeply underlies all of them, regardless of whether they pre-date or post-date Leibniz.

The fact that these and many other recent attempts to describe and explain sociohistory contain substantive assumptions that Plato, Aristotle and Medieval Christian philosophers bequeathed to us has at least two possible interpretations:

- unlike the fundamentally wrong models in cosmology, geohistory and biohistory that prevailed five centuries ago, Classical and Medieval models of sociohistory are fundamentally right and our proper task is to clarify the details; or

- like the fundamentally wrong models in the other historical sciences, Classical and Medieval models of sociohistory are fundamentally wrong too, and further attempts to make them work will continue to be counterproductive.

The history of science suggests that the latter is more likely to be right than the former, and offers hints for getting beyond some of the constraints imposed on studies of sociohistory by substantive uniformitarianism.

Models based on the metaphor of state changes offer one - but not the only - important alternative to sociohistorical models based on the metaphor of growth. Radical historical changes may be analogous with physical phrase transitions of which melting and freezing are common examples. Here, one of two stable states (liquid, solid) exists on either side of a critical point on an independent variable, and the transition from one state to another happens almost instantaneously as the critical point is reached from above or below. Within broad limits, further changes in the independent variable do not yield comparable changes in the equilibrium state of the material.

Physical phase transitions typically are reversible - raise the temperature and the ice melts, lower it and the water freezes, and so on indefinitely. Possible examples from geohistory are repeated coalescences and fragmentations of the continents, as well as repeated geomagnetic polarity reversals in which the ratio of the duration of stable periods to transitional periods is approximately 1000:1.

Biological phase transitions are to some extent analogous with physical phase transitions, but they are more likely to be irreversible. Examples range from the fertilization of an egg and the shift from placental encapsulation to structural autonomy at the birth of a mammal, to regulatory gene mutations and the presumed emergence of “hopeful monsters”. In each case, the transition from one state to the next is rapid and the states that precede and follow a transition are relatively stable and enduring. Yet within each state a great deal of change can occur, some of which derives from changes that occurred in the previous state and some of which does not.

Possible examples of irreversible phase changes in geohistory and biohistory include the abrupt termination at -4000my of the so-called Late Heavy Bombardment Period that may have marked the end of the accretion phase of all of the inner planets, and the transition from a reducing to an oxidizing atmosphere at -2000my that made possible the rapid emergence and explosive diversification of aerobic life at the beginning of the Cambrian.

Of course, the ultimate state change is the so-called Big Bang in cosmology. While many details of the Big Bang remain unknown, the Steady State model that once was its prime competitor and that presupposed a version of substantive uniformitarianism with which observational data were incompatible has been ruled out.

In the context of sociohistory, “revolution” in a political sense seems to have some of the connotations that I am attempting to associate with state changes in the physical and life sciences, but the two are not the same. The analogy implied by agricultural, urban, industrial, and scientific “revolutions” is that between a political or governmental change within a society on the one hand, and some other kind of change within a society on the other. Applying the concept of “revolution” to the issues at hand may or may not have heuristic value, but it is not the analogy that I am seeking. But see how our language gets in the way: “state changes” such as melting and freezing clearly are not “state changes” in the same sense as were the French and Russian revolutions, despite the fact that new “states” emerge after both kinds of “changes”. Analogies are extraordinarily powerful conceptual devices, but their contributions to our language and worldview are double-edged swords. I’m groping and do not know exactly what I’m looking for - but I know that “revolution” isn’t it.

Decisions to use a continuous or a discontinuous model and to seek mechanisms appropriate to the selected model do not necessarily emerge from one’s data; on the contrary, since we are likely to see what we look for, the model may be logically prior to the data. Likewise, the selection of a model may depend in large part on the prior selection of a particular resolution level at which to conceptualize a problem, a classic example of which is provided by the U-C debate in geology.

When all of geohistory was believed to have occurred within only 6000 years, divine intervention offered the only plausible interpretation of the very scanty data that were then available, and the catastrophists were dominant. When time ceased to have a recent origin and data remained somewhat scanty and lacking in detail, extrapolation from currently observable gradualistic processes such as erosion and deposition suggested that the present really was the key to the past, and the uniformitarians were dominant. But as more geological details began to suggest that major changes occurred quickly during short periods separated by broad expanses of stability, previously unknown mechanisms that are not currently in operation have had to be found to account for the data, and “neo-catastrophists” are on the rise again.

From a slightly different perspective, consider a particular social event such as the U.S. student protest movement in the 1960’s. By focusing on one even rather diffuse event

within a single society over a period of one or a few decades, almost any conspicuous social change can appear to be "revolutionary". By focusing on the same event over a period of hours, days or weeks, it can appear to be an evolutionary or developmental sequence. By focusing on it in the context of U. S. history as a whole, it can appear as one of a long series of minor disturbances in the social order.

Volcanic eruptions are useful analogies in geology. Although volcanoes may behave discontinuously, their eruptions are essentially local events that cannot meaningfully be conceived as discontinuities on the scale of geohistory as a whole. Conflating local events that recur (like volcanic eruptions and protest movements) with global events that are unique (like the solidification of the earth's crust and the emergence of *Homo sapiens*) is to devalue the currency, yet the decision to split or lump may be more aesthetic than scientific, at least until the prime movers are entirely clear in both cases.

With aesthetics firmly in mind, consider the broad contours of sociohistory from four resolution levels and speculate: What do apparent differences in contours imply concerning underlying differences in mechanisms and processes of change?

If we choose the world's greatest contemporary civilizations as our units of analysis, trace them backwards in time to their apparent beginnings a few thousand years ago, and examine the myriads of major and minor changes in them that are detectable at that resolution level, we might decide that a continuous model is most appropriate for representing and understanding what we see.

If we then alter the time scale so that we can treat the sociohistory of *Homo sapiens sapiens* as a whole as the unit of analysis, we might explore the applicability of discontinuous models to accommodate a) the emergence of the Ice Age art traditions of Western Europe, b) the invention of agriculture, and c) the onset of the explosive radiation of social forms that occurred after the food production threshold was crossed, some of which led to the emergence of the high civilizations that we viewed from a continuous perspective a moment ago.

If we alter the time scale again so that all of prehominid and hominid sociohistory becomes the unit of analysis, only a handful of changes can be observed or inferred with any reasonable degree of accuracy. They include events such as the genetic separation of the prehominids from the other apes, the appearance and disappearance of several hominid species, the emergence of language and true tools, and the invention of agriculture and civilization. From this perspective, changes are of such magnitude, their implications so pervasive, and their onsets so abrupt, that a discontinuous model seems to be worth exploring. If such is chosen, then each long period of stability or equilibrium that is terminated by a sudden event is an era during which minor variations develop around a species-wide theme, and in which continuous change is not necessarily germane to the onset of the next transitional event.

At this resolution level, the last ten thousand years ceases to be a period of gradualistic anagenesis or explosive cladogenesis derived from features of hominid societies in the

Pleistocene. Instead, it appears as a momentary and chaotic transition zone between the planet-wide shifting equilibrium that preceded the end of the most recent glaciation and some other equilibrium that may emerge in the next few thousand years if we do not destroy ourselves in the meantime.

From this perspective, one who attempts to understand human sociohistory as a whole by studying the events of the last ten millennia may be likened to one who attempts to understand a river by studying the behavior of water droplets adrift somewhere between the top and bottom of a great water fall. Insofar as ostensibly different forms of present day human social organization are nothing more than minor variations on a single theme that is intrinsic to the species as a whole but expressable in diverse idioms, questions about mechanisms and processes underlying historical transitions from one of those forms to another simply may be trivial, deeply interesting to a myopic and self-centered species but of no consequence in the larger scheme of things.

If we alter the time scale drastically once again, perhaps the only sociohistorical events of any consequence that remain visible are the crucial genetic differentiations that led ultimately to the main peaks of sociality an our planet (Wilson 1973:379-382), represented by colonial hydrozoans such as Portuguese men-of-war, social insects such as ants, termites and bees, and social vertebrates such as chimpanzees and humans. Differences between those peaks are undeniably enormous; whether they derived from mechanisms and processes operating continuously or discontinuously - or both - is in principle a researchable question.

The two competing views entail major differences in theory and method not only at the level of grand speculation, but also at the level of more directly researchable problems in sociohistory, a few examples of which are summarized in the following paragraphs.

If hominid evolution occurred continuously, it follows that significant gaps in the fossil record are due solely to incompleteness of the record, and that finding a series of finely graded “missing links” should permit us to reconstruct the “chain” that connects us backwards in time to our earliest prehominid ancestors. But if it occurred discontinuously, it follows that gaps in the fossil record may be due to sudden emergences and sudden extinctions, and that long periods of morphological stability that often occur between emergences and extinctions may be the rule rather than the exception. The continuous model leads us to search for intermediate forms, while the discontinuous model leads us to search for processes and mechanisms that could underlie abrupt changes.

Given the paucity of relevant direct evidence, recent attempts to reconstruct early hominid societies rely heavily on the continuous model as the rationale for conducting research with living nonhuman primates and surviving human hunter-gatherers. For example, paleodemographers who adopt the continuous model use demographic and ecological data from modern hunter-gatherer societies, in conjunction with model life tables and computer simulations of demographic processes, to make inferences about

demographic aspects of extinct hominid populations and societies. But the underlying assumption creates an interesting problem.

If the continuous model is valid, the demographic rates that are prime targets of these paleodemographers are in a sense perpetually moving and their directions and rates of movement are unknown. Hitting the targets under those conditions is both unlikely to happen and virtually impossible to verify. On the other hand, if the discontinuous model is valid, these paleodemographers cannot use their methods to learn much that is significant about extinct creatures that are genetically distinct from modern *Homo sapiens sapiens* since some of the most important differences between us and them may lie squarely in the area of demographic rates.

Interestingly enough, all is not lost, for if the continuous model upon which this work rests is invalid, there is at least the possibility that the work done in its name can be productive. For that to occur, it must be applied exclusively to extinct populations of *Homo sapiens sapiens* who, from the perspective of the discontinuous model, are virtually indistinguishable from us.

Attempts to reconstruct the history of language encounter similar problems. If we suspect that the extraordinarily complex set of mechanisms whereby humans receive, process, store, recall and transmit symbolically coded and elaborately structured information could have evolved piecemeal, then it is appropriate to search for a chronologically ordered sequence of tiny changes that can account for the emergence of human language from nonhuman primate communication. Otherwise, it is appropriate to search for mechanisms whereby large-scale, nondestructive genetic changes in the central nervous system could occur in a step-like fashion.

Anthropologists, sociologists, historians, economists and others who attempt to explain sociocultural diversity among 20th century human societies, and attempt further to identify the means whereby that diversity developed, have a great deal of information at their disposal, but the choice of models remains problematic. If complex social forms emerged incrementally from simple ones and intermediate forms lay between the extremes, we should be able to use data from contemporary societies of varying degrees of complexity to construct valid typological histories of gradualistic sociocultural change. But if the continuous model is invalid, then appearances may be realities, large scale sociocultural changes such as the invention of agriculture appear to be an “all or none” events; there are sharp structural discontinuities between contemporary social forms; there is little empirical evidence with which to support assertions that typological histories correspond to chronological histories; and missing “links” in the sociocultural “chain” may never have existed.

In 20th century sociohistory, state changes have been used cautiously and intermittently as reference points for models of events that seem to be relatively sudden and step-like. For example, Henry Adams (1909) proposed an all encompassing interpretation of history based squarely on the physical phase transition model discussed above. Although it had no lasting impact on sociohistorical theorizing, it was at least an honest

attempt to try something different. Similarly, work on evolutionarily stable behavioral states by Maynard Smith and his colleagues uses reversible phase transitions as the dominant metaphor. And Thom's catastrophe theory has been adopted by Renfrew and his colleagues to model changes in settlement patterns in situations where continuous changes appear to be impossible. Such work is encouraging, even though it remains rare.

Whether state changes provide the best metaphor for discontinuous changes in sociohistory is not the issue here. Rather, I am searching for an alternative metaphor that can get us beyond our cultural fixation on continuous models based on the metaphor of growth. If state changes do the job, we should use them; if not, we must find something else. In either event, two millennia of *Natura non facit saltum* is enough.

One of the most important reasons for the overwhelming acceptance and persistence of continuous models in sociohistory, aside from the fact that they seem to work for some purposes and in some areas of inquiry, is that they embody units of analysis and scale factors that reflect conventional wisdom, and their operations seem to be intuitively simple. It is easy enough to imagine that almost anything can turn into almost anything else if only enough time is allowed. But *Natura non facit saltum* simply begs the question of mechanisms and processes by which change occurs, in effect replacing the divine intervention of the 19th century catastrophists with another *deus ex machina* that works much more slowly than, but just as mysteriously as, its predecessor. Hence, it is inappropriate to invoke Newton's principle of simplicity to bolster one's choice of a continuous model. If discontinuities occur in sociohistory as they do in other historical sciences, they must be treated as discontinuities; to force them into an inappropriate mold does not simplify them. Rather, it makes them incomprehensible.

A remarkable achievement of 19th century Western science was its success in promoting widespread acceptance of the idea that ordinary events, operating continuously over long periods, could produce extraordinary changes in geohistory and biohistory. One of the great tasks currently facing Western science is to put that 19th century achievement into proper perspective. The present is the key to the past only in certain respects and for limited periods of time. In other respects and in the long term, we live in what appears to be a capricious universe, but its apparent caprice may be an artifact of our prejudices. The ultimate goal of constructing a comprehensive, coherent, naturalistic theory of the universe that does its job as effectively as did its Medieval predecessor will necessitate widespread acceptance of the fact that nature sometimes makes leaps. The question of how it leaps in each instance is amenable to empirical research based strictly on Newton's methodological postulates.

Bibliography

I compiled the following list of references for an earlier and longer version of this article entitled “On Uniformity in Sociohistory”. This streamlined version of the article is very light on citations. Since both papers rest on exactly the same set of references, I have included the full list here as a bibliography rather than as a list of References Cited.

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