THE QUEST FOR PATTERNS IN META-HISTORY

"When I was in school I studied biology. I learned that in making their experiments scientists will take some group—bacteria, mice, people—and subject the group to certain conditions. They compare the results with a second group which has not been disturbed. This second group is called the control group...In history there are no control groups."

—*Cormac McCarthy.* All the Pretty Horses, *1992*

The insidious thing about the causal point of view is that it leads us to say: "Of course, it had to happen like that," whereas we ought to think: it may have happened like that—and also in many other ways.

—Ludwig Wittgenstein. Culture and Value. *Published in English Translation, 1980*

The field of historical events is too complex and too lacking in exact analogies in its recurrence to coerce the mind to a particular interpretation of the causal sequence, but, even if the mind could be coerced, the historical observer might always turn out in the end to be an agent of history rather than an observer of it, with a sufficient stake in the contests of history to defy conclusions which should compel the mind but not compel the interested self.

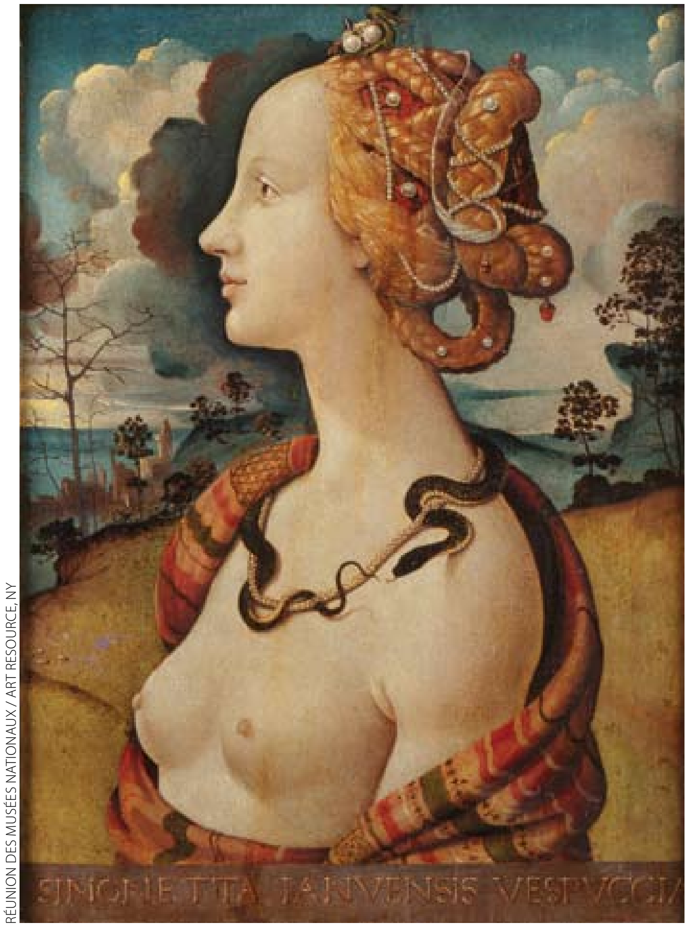
—Reinhold Niebuhr, "Ideology and the scientific method," 1953

By David C. Krakauer

Charles P. Snow's 1959 Cambridge Rede lecture on "The Two Cultures and the Scientific Revolution" simultaneously lamented the fragmentation of society into scientists and artists/humanists, and sounded a triumphant note for the great ascendancy of science as the true path towards understanding. Society still has not recovered from the characterization. We live with a dual picture, one where imperious scientists stick their empirical, reductive snouts where they are not wanted, while the relativistic artists and humanists labor at textual scholarship like 16th-century philosophers oblivious of the coming scientific revolution.

In this article, inspired by a recent meeting at SFI on history and complexity, and using the historical sciences as my subject, I want to show that this perspective is not only simple-minded, but misses a whole set of mental and methodological preferences that do not segregate along the lines of the science–art/humanities divide.

There is, for example, an equally interesting distinction to be made between historical and ahistorical explanation. In order to understand how a clock works, we can take it apart, reassemble the mechanism, and try to figure out how to make a very small wheel behave as if it were a large planet— such that the wheel and the planet mark the same passage of time. No need for history here, just an engineer's ingenuity. But when we seek to understand how the clock came into being, from what precursor and what process of manufacture, then we need to consider the history of the object. The historical reconstruction does not follow the same logic as the sequence of the clock's manufacture—the history is represented by a long chain of trials and errors, with the best available solutions making their way into the final product. This is very similar to the understanding of an organism through its development or through evolution, and



Portrait of Simonetta Vespucci, mistress of Giuliano de' Medici (ca, 1480), by Piero di Cosimo, at the Musée Condé, Chantilly, France.

the understanding of a constitution through legislation or through its historical derivation. The two modes of explanation are very general and represented within many fields.

And there is another distinction to be made between the truth of particulars and the truth of generalities. At a crime scene, a photographer best serves the interest of the case by preserving, with as little bias as possible, the configuration of the evidence. In a portrait, a painter can capture more than a photographer by abstracting away detail and representing in shape, color, and hue, less obvious and more essential characteristics of the subject. Both painting and photograph are "true" and span a spectrum comprising very detailed accounting and very general abstraction.

In an effort at synthesis I will emphasize some striking parallels between history and science, and discuss a few biographies illustrative of particularist and generalist tendencies in a number of different disciplines. I will try to show that a contingent, historical dimension to a problem need not be an obstacle to science, and that methods exist, many of which have been applied in biology, to deal explicitly with limited sample sizes, the multiplicity of outcomes, and the problem of counterfactuals.

Both historical versus ahistorical explanation, and particular versus general representations have their roles in both the sciences and the arts and humanities. Rather than apply Snow's demarcation criterion, we can inquire into these more cross-disciplinary issues and explore a fuller compass of ideas and personalities. Natural languages are thought to be better suited to this integration than formal languages. The primary reason for this is that natural language builds narratives of particular events through a recursive structure suited to the representation of arbitrarily large scales. The great success of Darwin's *Origin of Species* in providing a conceptual framework for Linnaeus's nomenclature without a single equation demonstrates the power of narrative even for a biological phenomenon. There will be no equations in this essay.

Meta-History–The Illusion of Single Sample Sciences

A problem facing all historical analysis is that cosmological, geological, evolutionary, and cultural histories are in aggregate: singular events. This uniqueness precludes the use of the powerful scientific tools of multiple observations and replication, and all observations come to carry equal weight. Pascal wrote, "Had Cleopatra's nose been different the whole face of the world would have changed." The quote is from the *Pensees* on the topic of vanity, and refers to an exercise in the multiplication of contingencies. Starting with the injurious consequences of Mark Anthony's love of Cleopatra following Julius Caesar's assassination, Mark Anthony is pursued by Octavian, defeated at Actium, finally coming to a tragic end in a double suicide pact with Cleopatra. Pascal deems society, as a whole, vulnerable to individual acts of folly. This is similar to a non-robust statistic applied to data, where changing a single observation leads to a very different conclusion. Paul Valery went so far as to define history as "the science of what never happens twice."

But just because history changes course frequently according to individual actions, might we still not find generality? Edward H. Carr, in his book *What is History?* states that "What distinguishes the historian from the collector of historical facts is generalization." This resembles the distinction made between the natural historian taxonomist and the scientist. One seeks the myriad details of pattern, and the other—the patterns above the detail. Perhaps the great example of the latter is the work of Charles Darwin. Darwin shoehorned, somewhat shamelessly, all of natural history into the iterative algorithm of natural selection. While there appears to have been a single origin of life, there have been countless instances of natural selection, and the adaptive diversity of life provides the evidence. Biological evolution offers a strong model for historiography as it makes a science of sensitivity to initial conditions, self-similarity, and degeneracy. Darwin sought repetition across the particulars of lineages, having recognized that the phyletic whole was indivisibly unique.

The scientific method—that loose collection of properties including empiricism, experimentalism, quantification, falsifiability, parsimony, and simulation, has been built up around the possibility of replicability. Replication serves at least two purposes: one is the extraction of regularity, and the second is the building of consensus through independent experiments. Consensus is dependent on independent researchers seeking to refute one another, performing similar, if not identical experiments—the greater the value of the work, the greater the need for independent verification. There is a quality to science that seeks to remove the individual from the hypothesis. This objective distance is obtained when objects cease to be in Neibuhr's phrase "agents of history."

The difficulty of replicating observations is not unique to the humanities and social sciences. There are a number of empirical, single sample sciences, all of which have a historical dimension, which I refer to in the title as the meta-historical sciences. These include the *non-adaptive, meta-historical sciences:* geology and cosmology, and the *adaptive meta-historical sciences*: evolutionary biology, anthropology, and archeology.

Geology and cosmology are meta-historical sciences as both the planets and the universe have come into existence over the course of time from a suitable initial state. We consider these sciences within a variational framework, with order derived from an appropriate action principle, in which some function is minimized (free energy) or maximized (entropy). However, physical theory seeks the parameters that best fit these functions to a more or less complete body of data. The strong dependencies in the data allow that these lookup tables are substituted with summary, mathematical rules. So while there is a historical process, the laws governing history are fixed and few.

Biological and anthropological theory seeks to find regularity within a more contingent domain, but concords with physical theory in trying to develop minimal-parameter models for observations. However, these sciences describe adaptive systems that historically encode functions that best fit past observations and effectively predict future regularities. Their unique histories have an enduring influence on the future, and the rules governing their evolution are not unchanging but transform alongside the system. There is a statistical, inferential quality to the adaptive, meta-historical sciences, which echoes the inferential character of human theories of history.

Merging History with Meta-History through Complexity

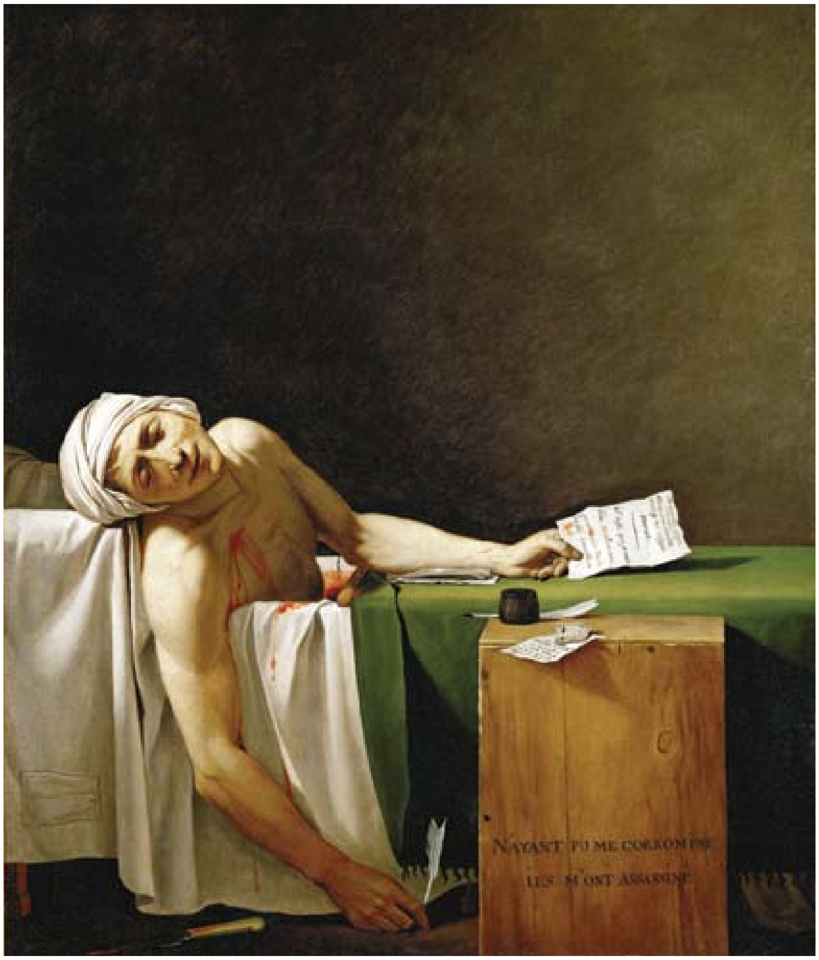
A basic meta-historical assumption is that contemporary observations cannot be understood *only* through the application of timeless rules, but need to be understood as having evolved through a series of symmetry-breaking events or historical contingencies—where from a set of equally likely outcomes, one is selected. The trend in the natural sciences has been to reduce the dependencies of phenomena on their initial conditions and contingencies, and to isolate systems with a small number of degrees of freedom. This is best exemplified in physics. Explanations are shifted progressively away from initial conditions towards theories and laws. In systems with little degeneracy, this approach has proved to be highly effective.

In biology, economics, and anthropology, this approach has met with more modest success, although the approach in these fields is far more recent. There has been a move, therefore, to explore new forms of reductive theory of greater applicability to meta-historical disciplines, and this has generated a portfolio of approaches related to complex systems science. Explanations in complex systems science often make use of multiple mechanisms for explaining order, such as natural selection and free energy minimization in protein folding, or human decision-making and phase transitions in economic markets. The use of stochastic processes to reconstruct molecular, phylogenetic histories is a strong example of historical theorizing, making use of largely ahistorical properties of chemistry to generate distributions of alternative, probable, molecular pasts. The presence of alternative states of a single system is referred to as meta-stability, and has played an equally important role in historical writing, in the form of counterfactual history.

Counterfactual History as Metastability

For want of a nail
The shoe was lost.
For want of a shoe
The horse was lost.
For want of a horse
The rider was lost.
For want of a rider
The battle was lost.
For want of a battle
The kingdom was lost.
And all for the want
Of a horseshoe nail.

In 1777 in the town of Saratoga, NY, were fought two of the decisive battles of the American Revolutionary war. The British fighting under John Burgoyne faced the Americans under Horatio Gates. The outcome of the engagements at Freeman's farm and Bemis Heights was the defeat of the British and the subsequent commitment of France to the revolution. Robert Sobel in his 1975 book *For Want of a Nail: If Burgoyne Had Won at Saratoga* explores the consequences of an American defeat, leading to the withdrawal of French support, the surrender of the colonies, and the final establishment of the United States of Mexico. The study amplifies the importance of a single event, through a long chain of causality, leading to the divergence of two national futures beyond familiar configurations.



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The Death of Marat, Jean Paul Marat, politician and publicist, dead in his bathtub, assassinated by Charlotte Corday. Jacques-Louis David (1748-1825). Oil on canvas.

Alternative histories play with the precariousness of decisions and critical turning points to generate an ensemble of futures. This ensemble undermines our confidence in the stability of factors generating our realized societies. Identifying the most probable outcomes of alternative histories is an instance of what is called stability analysis in non-linear dynamics. The terms of non-linear dynamics can be of some use in counterfactual history.

In dynamics, an important question is how many non-wandering sets a system possesses. A non-wandering set consists of a set of points in some space, such that all orbits starting from these points come arbitrarily close, arbitrarily often, to these points. The sets are classified using mathematical terms as fixed points, limit cycles, quasiperiodic orbits, and chaotic orbits, describing the long-term distribution of points in space. The motion of planets in our solar system represents an instance of a stable limit cycle, where the planets remain in stable orbits and do not collapse to a single fixed point or wander about chaotically.

Changing the parameters (such as the mass) of a system can induce a change in the composition of a non-wandering set through a bifurcation, whereby orbits move to the neighborhood of a new set of points—such as from a limit cycle to a chaotic orbit. The basin of attraction of a dynamical system is the set of all initial states approaching the attractor in a long time limit.

From the dynamical perspective, counterfactual history is about establishing the basins of attraction of a system and identifying those parameters that when modified, lead to a transition from one basin to another or continued residence in the same basin—robustness. Establishing basins of attraction in low-dimensional mathematical models can be accomplished relatively easily using computers, but how might we go about this when dealing with an alternative outcome of World War II, as explored in Philip K. Dick's novel *Man In The High Castle?* In this novel Japan and Germany come to occupy Europe and the United States—a disconcerting, counterfactual outcome. But the plot really serves as the vehicle for an exploration of robust properties of society, such as national identity, moral probity, and the spirit of resistance to tyranny. The Yale University Cold War historian John Gaddis has compared counterfactual narrative of this kind to Monte Carlo simulation—the multiplicity of possible narratives seeks to isolate invariant outcomes from inessential noise.

However powerful narrative might be as an organizing tool, nonlinearities in physical systems can make the informal identification of generalities very difficult. In 1917 Vilfredo Pareto noted how the physical sciences benefited enormously from the theoretical convenience of living in a solar system with a single massive sun. This reduces the complexity of planetary orbits to a two-body problem—the sun paired with each of the planetary masses. Physics from Galileo to Newton was able to make progress as a result of the happenstance of a relatively simple distribution of planetary mass. In human history, we seldom observe such convenience, since multiple, equally important factors are often in play. The question then becomes, how is it that historians make any progress at all?

One way historians solve this problem is to identify analogous precedents and exploit remarkable properties of human psychology. Most events have some features that are shared. Once those shared features have been discovered, it is sometimes possible to extrapolate from one case to another—in effect, historians practice case law. Furthermore, counter-factual historical reconstruction is facilitated by the amazing ability of human brains to extract patterns from very high-dimensional data sets. These are the same reasons human chess and Go players remain competitive against the best of our combinatorial game algorithms. The clues to a quantitative science of history then lie in our ability to decompose dynamical systems into units serving as precedents, and develop more effective insights into how we detect pattern.

> Thus through decomposition we are able to multiply the number of instances of an event and derive virtual control groups.

Decomposition Towards a Science of History and Hidden Control Groups

Why have the social sciences and history not made more progress? Why is history not cumulative in the fashion of natural science? Bertrand Roehner and Tony Syme in their recently published *Pattern & Repertoire in History*—a work of what they call analytical history—argue that the explanation is a failure to decompose events.

Roehner and Syme suggest that natural science has more effectively simplified problems through decomposition, which means breaking a system down into components that can be treated more systematically. They use the example of the physics of a glass of Coca-Cola placed in the sun. A full understanding of the physical response requires knowledge of optics (light to heat), statistical mechanics (propagation of heat), hydrodynamics (convection streams), and thermodynamics (for diffusion of heat). Each of these fields was worked out in simple systems where they could be formulated with relatively few exceptions. The power of the scientific method emerges in the synthesis of these ideas.

The approach Roehner and Syme advocate is to break historical events down into more elementary building blocks or elements of global events. These blocks will then be shared by very different events. There has only been one French Revolution, but there were three stormings of the Bastille, 20 meetings of the Estates General, and 15 instances of the confiscation of church estates. The virtue of the modular approach is to move from the description of the particular to the analysis of comparative events.

As an example of how history might make use of this approach, Roehner and Syme decompose several different events. These include the following:

- The meeting of the Estates General (i.e., Parliament) in France: This involved the formation of tactical alliances between the bourgeoisie and the clergy, and the reduction in the authority of the monarch. Both of these events of 1789 are echoes of similar events in previous years or in different nations, such as the formation of parliaments of the German states.
- Strategic planning in World War II: In 1942, Germany and its allies occupied continental Europe, while the United States and Britain controlled the seas. Russia was an ally. Replace Germany with France, the United States and Britain with Britain, and we have the Napoleonic wars.
- Russian Revolution: The revolt of the Kronsdat (Russian naval arsenal) sailors in 1917 and their march on Petrograd played an important role in the revolution. But this was just one of several mutinies that occurred and were suppressed: in 1905, a mutiny following the death of a sailor; in 1906 a rebellion of two fleets; and in 1921, an uprising initiated by a new resolution opposed by Trotsky.

Thus through decomposition we are able to multiply the number of instances of an event and derive virtual control groups. While there is only one *Homo sapiens,* there are numerous species with an eye or ear or nose. The conditions for the evolution of these traits can be studied comparatively, and can thereby overcome the absence of the critical control groups described by McCarthy—noted in the opening epigraph—as the problem for a scientific history.

To illustrate the point, when considering the horse, the paleontologist must decompose it into informative anatomical units—skull, jaw, and teeth. Then he or she must find a sequence of homologous units through evolutionary time. Thus while the French revolution might be unique, its units had ancestors or forerunners. The revolution of 1789 is made up from a number of event strata with identifiable correspondences. In this way, history ceases to be "creationist" and becomes "evolutionist." This also raises interesting questions about the relationships among the elements, and about topics such as scaling relationships and allometry, for which abstract regularities might exist and take us in the direction of a more law-like history.

The Culture of Particulars

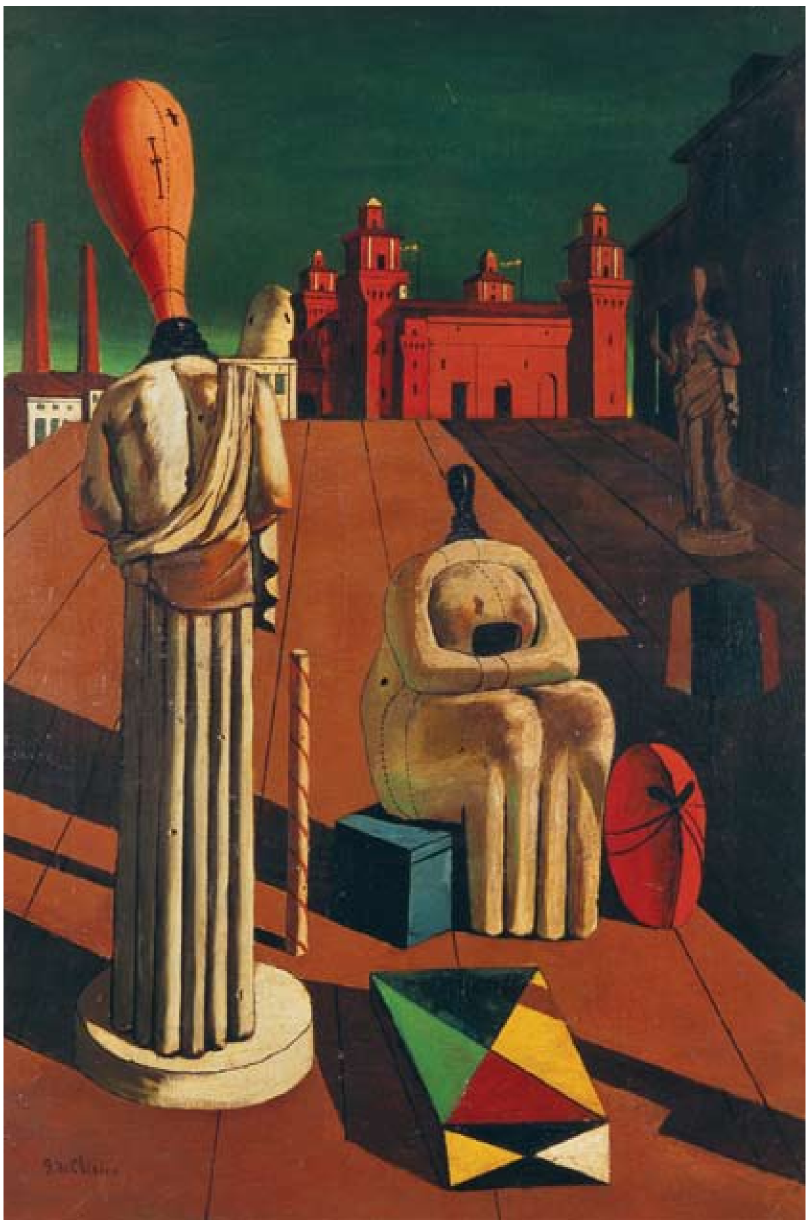
Even if we were successful in identifying analogies and homologies in history, there remains in history a high priority placed on the role that particular events have played in establishing contemporary patterns. The ahistorical approach seeks to minimize contingency and downplay psychological causality when explaining pattern. The historical emphasizes the enduring role of initial conditions and contingent events unfolding from unpredictable psychological responses. The ahistorical tradition has been allied with those symbolic systems effective at expressing regularity such as mathematics. The historical tradition has been drawn to narrative expressed in the natural language of sequential particulars, particularly individual lives. Carlyle wrote, "History is the essence of innumerable biographies," and Emerson wrote, in the same spirit, that, "There is properly no history; only biography."

The particularist sees human history as a unique event whose exposition demands an enumeration of events. There is no denying that general processes are important, but since we can never know them (no repeatability) they resist generalization. Interestingly, a comparable position remains strong in the biological sciences. Consider a statistical analogy. With a single set of data points, interpolation can be preferable to a fit with a fewer number of parameters. This is because there will never be an opportunity to test the fit out of sample, on a larger, independent body of data. Hence the very best fit, effectively a point-by-point description of events, represents the desirable model. The second criticism is that human consciousness is both subject and object of history and, hence, interpretive accounts are unavoidable. Unlike physics or biology, where atoms or DNA are directly subject to chemical rules, individuals exercise deliberative control over their futures.

Double Micro-Biography in Extremis

One point I have tried to make throughout this article is that many of the putative antagonisms between history and the natural sciences are present in a variant form within history and within the natural sciences. It is not only a matter of replication and decomposition, but disposition. Some minds favor reduction, synthesis, and ahistoricism, whereas others favor details and chronicles. As an illustration, let's consider briefly the life and work of Oswald Spengler and Michael Oakeshott, both historians.

Oswald Arnold Gottfried Spengler was born in 1880, the son of a mining engineer, and the author in 1917 of *Decline of the West.* He advocated an organic, developmental theory of history with all culture passing through predictable stages of a life cycle from birth to maturation through to senescence. Perhaps more a poet than an analytical mind, Spengler mixed his metaphors and spoke of developmental stages in seasonal terms as spring, summer, and autumn. In spring, the basic principles are arrived at, typically in terms of the religious beliefs of a society. A culture in full form in its summer realizes the potential of its principles and creates art and artifacts of enduring value. In the autumn of its development a culture enters into the civilization phase. Here economics dominates political action, nations tend towards imperialism, states enter into contention, and despots arise (Caesarism). The common principles once uniting society are no longer respected, and artistic creation, no longer rooted in a whole culture, drifts into fads and fashion. Western culture, according to Spengler, reached its phase of civilization in 1800. While a fastidious student of minutiae, Spengler was clearly influenced by Hegel, and saw in the history of civilization a law-like, unavoidable regularity. To contemporary minds, there is little compelling in Spengler's writing other than his delicious pessimism and poetic flourishes. However, Spengler's interest in historical cycles, which influenced the work of Arnold Toynbee, and more recently Peter Turchin, remains a fascinating research problem.



The Disquieting Muses (1916) by Giorgio de Chirico, at Coll. Mattioli, Milan, Italy.

Michael Oakeshott was born in 1901, the son of a civil servant and author in 1983 of *On History* and in 1986 of *Experience and Its Modes.* He thought of all human experience as consisting primarily in establishing a world of ideas, in which these ideas achieve a coordinated unity. Experience is fundamentally modal, meaning that the perspective or organization of our experience is diverse and comprised of approaches that are irreconcilable. The historical mode represents the attempt to render current experience consistent with past fact, whereas the scientific mode seeks consensus through establishing quantity. History, Oakeshott argues, is the attempt to account rationally for historical change. Historical explanation is an explanation of the world in terms of change and an exploration of the process or mechanisms of change. For Oakeshott, events are distinguished from instances—the latter the subject of scientific investigation—which seek to determine the minimum conditions required to explain observations. Events arise through their extensive dependencies, relations, etc. This makes causality, as practiced by scientists in search of quantification, effectively impossible. Oakeshott suggests that the defining property of history is to understand the equal contribution of all events across all of time—"thus every historical event is necessary..." he writes. Even a strong personality such as Frederick the Great, who might seem to have made disproportionately significant contributions to world affairs, needs to be understood in relation to the larger network of peasants upon whom he depended.

Neither Spengler nor Oakeshott present their ideas in a form familiar to the natural sciences, and yet their positions present an echo of debates within natural science. Oakeshott would carve out some frequency range and call this history. Spengler sees no need for restriction and insists that history is no less a mechanical process than biological development. Oakeshott thinks of the historical mode as one in which the present can only be understood by reconciling it with salient events in the past. Spengler thinks of history as important in charting the current disposition of our degeneration. Oakeshott wants to sever the ties between science and history by making them incommensurable.

It is not a stretch to see in these positions some features of the arguments between high-energy physicists and evolutionary biologists. The physicists, like Steven Weinberg, seek to restrict initial conditions and trace the origins of order to the earliest stages of the universe, whereas the biologists, such as Stephen Gould, stress the fundamental role of unfolding contingencies in generating extant biodiversity. What distinguishes both Gould and Weinberg from Oakeshott and Spengler is their belief in the supreme value of quantification and consensus.

The Epistemic Spectrum

We can move beyond biography and consider historiography more broadly, in terms of a spectrum of descriptive detail and explanation, analogous to the electromagnetic spectrum of physics. The electromagnetic spectrum covers a range of electromagnetic radiation spanning the low frequency infrared through the high frequency gamma rays. The lowest frequencies travel the greatest distances and are able to diffract around obstacles but offer low resolution. The highest frequencies have the highest energies and can be used to resolve the smallest objects as they sample a large number of points in space and time. When building devices to resolve the invisible world, we deploy those frequencies best suited to our needs: the low frequency radio waves to scan great distances, and the highest frequencies to reveal the microscopic structure of matter. In order to understand the invisible world of history we need to explore an analogous full *historical spectrum*, using low frequencies for regular, granular patterns and high frequency methods for detailed sampling.

Ranging the Spectrum

The lowest frequency historical accounts, leading to a consideration of laws of history are highly parsimonious expressions of regularities that transcend all culture and all time. In this frequency range we could place historicist philosophers such as Hegel. While Hegel has not a single mathematical formula in his work, he championed a highly reductive, somewhat deterministic view of history. In Hegelian theory, an almost Platonic idea becomes increasingly realized through society. History is directed forward such that society, as long as it remains a part of history (the Egyptians, we are informed cryptically, opted out of history) produces ever more perfect representations of itself. This form of historicism is the most physics-like of histories, as it minimizes the role played by initial conditions and develops an aesthetic criterion for progress.

In the intellectual low-frequency accounts exist perspectives adopting quantitative techniques, typically based on the application of statistical and dynamical models without appeal to law-like regularity. In his book *Historical Dynamics,* Peter Turchin asks explicitly, "Why do historical sociologists use such a limited set of tools?" and argues that a theory of state formation and extinction is inherently a dynamical problem with a dynamical systems solution using models derived from theoretical ecology.

Into the mid-range of the spectrum are those borrowing metaphors and generality from the natural sciences, downplaying the pivotal role of the individual, but who do not insist that the transfer of ideas extend to adopting quantitative techniques. This position is strongly advocated in John Gaddis's recent book, *The Landscape of History.* In *Landscape,* Gaddis criticizes the idealized, reductive methods of economics with its emphasis on single, proxy, independent variables such as utility and static optimization. Gaddis favors the metaphors of complex systems science: sensitivity to initial conditions, self-similarity, and degeneracy arising from frustrated states and the value of simulation. Unlike Turchin, Gaddis does not model history, but uses concepts from dynamics as metaphors.

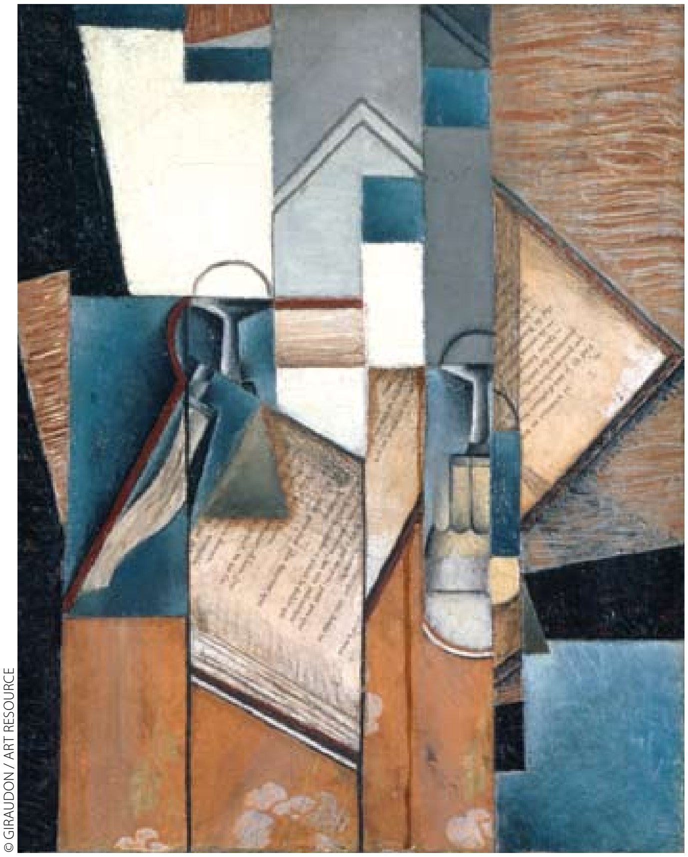
Into the higher-frequency, ultraviolet bands, reside those historians who observe patterns in nations, local communities, and family structures, but present their ideas in the informal logic of empirical argument. These frequencies constitute the median of historical output. And many of our outstanding contemporary historians can be placed here, including Kenneth Pomeranz, Niall Ferguson, Christopher Bayly, and Hugh Thomas.

Reaching the X-rays and gamma rays at the highest frequencies are historians who deride attempts to transform history into a branch of natural science. At these frequencies, individual psychology figures so large as to make statistical generality meaningless. As at the historicist extreme, here history becomes more philosophical, and the names of Vico and Herder come to mind. Isaiah Berlin presents some of these objections in his essay, "The Concept of Scientific History." Science is associated with the construction of ideal models from stable similarities across a range of observations. Such empirical abstraction, Berlin contends, needs to be based on recurrences. Science comes thereby to deal with the type, not the individual. Science seeks unity, whereas history seeks diversity. Berlin writes, "The description and explanatory language of historians, because they seek to record or analyze or account for specific or even unique phenomena… cannot, for that reason, be reduced without residue to such general formulae, still less to models and their applications."

Like any spectrum, the division into discrete value-ranges is arbitrary, and ideas fall upon the line rather haphazardly according to temperament and training. But the spectrum metaphor has value by making clear that the choice of frequency band reflects the magnitude of the object under scrutiny, and the need to consider multiple frequencies in order to present the many properties of the historical subject. The tendentious style of history—the choice of only one frequency—then becomes a matter of taste, reduced to a preference for blue over pink. There is no question that all frequencies are present in history; the challenge is to find some means of combining them into a complete account such that Berlin's *individuals* and *types* can coexist. This has been one of the great successes of evolutionary biology and presents great challenges to the sciences of complexity.

History and Complexity at the Santa Fe Institute

Many of these thoughts were provoked at a meeting organized by John Gaddis and me at SFI in the summer of 2005. It became clear that while the will towards a common language was present, significant technical difficulties impeded our progress. The tendency of physical scientists is often to dismiss detail as incidental and search only for regularity. For the historian, great richness lies in the sequencing of the particular, and in the narrative plausibility of networks of causality. This, however, is also a very common preference in the biological and social sciences. Having said that, Oakeshott was certainly on to something with his different *modes* of understanding, and there seems to be a level at which history and natural science is probably untranslatable. However, there are coarse-grained realities of interest to both communities, and these we felt are most evident in the history of conflict. In conflict, competing parties arise and engage in repeated interactions with a concomitant redistribution of resources. The mathematical analysis of the chronological pattern of conflict, the dependence of conflict on social and technological networks, the hierarchical structure of society leading to feedbacks which modulate lower levels of conflict, and those factors promoting a stable peace, emerged as themes of significant common interest. Our next step in a projected unification will be a meeting on "The Complexity of Conflict in the Context of History." This effort exemplifies a staple of SFI research, that progress is slow before a common problem and language have been established, and then accelerates from that point on. ◀



The Book (1913) by Juan Gris, at the Musee d'Art Moderne de la Ville de Paris, Paris, France.

Acknowledgements: Many thanks To Dan Rockmore, Tim Taylor, and Jessica Flack for very helpful suggestions for improving this article. Any remaining infelicities and obscurities are strictly of my own stubborn manufacture.

David C. Krakauer is an SFI professor.

A QUANTITATIVE SCIENCE OF HISTORY

In its ever-expanding quest to explore new frontiers, the Santa Fe Institute convened a group of researchers to explore whether there might be a quantitative science of history. Participants brought a broad range of viewpoints to the subject, which included the following: David Krakauer—Evolution of evolutionary theory: Narrative vs. mathematical history; Ken Pomeranz, UC Irvine—Long-term histories of economic growth; Doug Erwin, Smithsonian Institution—Paleontological history of the Earth; Elizabeth Saunders, Yale—Political science and the study of international security; Matt Connelly, Columbia—Contemporary international history; Geoffrey West, SFI—Scaling and other regularities in nature; Murray Gell-Mann, SFI—A history of language change; and Gagan Sood, Yale—Knowledge, disciplines and the scientific method.