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Context Changes Everything

How Constraints Create Coherence

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Constraints

An Introduction

Mechanical forces jostle things about but the motions they cause are Markovian. They forget their past; they are reversible. Likewise, Newtonian space and time are featureless containers that do not affect the basic properties of events that take place in them. In that received framework, measuring instruments with which physical processes are studied are assumed to be passive and transparent registers that do not fundamentally alter the entities and processes they record.

In the twentieth century, this pretty picture began to crack. Indubitable evidence that measuring quantum states necessarily alters the experimental outcome placed interactions, context, and time front and center.

Uncritically held assumptions about the role of context were first turned on their head by English physicist Thomas Young's famous 1801 double slit experiment that showed that light possesses a peculiar duality. Shining light through one slit onto a screen produced particle-like spots of light; shining light through two slits produced a wave-like interference pattern. What is light, really, a wave or a corpuscle? Far from revealing internal primary properties that remain unchanged regardless of the experimental setup, core properties of light differ depending on the interaction. Light appears one way in one context but different in another, depending on its interaction with the environment—in this case, a measuring apparatus. Instead of providing a faithful mirror of an essential and unchanging reality that is blind to interactions, the experimental context with which quantum states are measured alters results. Context leaks into the observed.

Over one hundred years later, German theoretical physicist Werner Heisenberg showed that one can know either an electron's exact position or momentum, but never both simultaneously. The information transmitted about the subatomic level is different depending on the experimental setup. Once again due to interference from the measuring instrument, Heisenberg's uncertainty principle set a limit to knowledge about subatomic particles.

The thought experiment that Nobel laureate Erwin Schrödinger described to Albert Einstein in a conversation was even more disconcerting. The uncertainty principle might have set limits to knowledge, but Schrödinger was concerned with its ontological implications. According to the standard Copenhagen interpretation adopted in light of the uncertainty principle, quantum systems should be conceived as clouds of possibilities, superpositions of states whose actualization depends on measurement. Schrödinger noted, however, that according to this interpretation, a real cat locked in a steel chamber and whose life or death depended on the state of a radioactive atom would be both alive and dead until a measurement is made.

Wave–particle duality was a dramatic wakeup call for physicists, but to the chagrin of working scientists since, context dependence has repeatedly been shown not to be restricted to the quantum realm. Because living things are quintessentially context dependent, biology was the discipline most recalcitrant to being shoehorned into a Newtonian mold. Organelles behave differently in a cell than isolated in a petri dish. Ontogenesis is heavily dependent on context. Epigenetic effects due to environmental interactions can alter gene expression and produce different phenotypic traits that persist even across several generations—without modifying DNA sequences. And we all behave differently around our parents than with our friends.

Water offers a surprising example of the propensity to ignore context. Although it is essential for life, water is often treated as inert background. Recent studies have shown, however, that, far from being the inert medium in which chemicals are dissolved, water is an active agent in at least 40 percent of the 6,500 known biochemical reactions. "Water exerted a huge influence on which chemicals survived and became a part of life, and which didn't. . . . The surviving molecules were the ones that were soluble in water. . . . 'That is how they were selected,'" Frenkel-Pinter states (Marshall 2021), implying a form of prebiotic selection by context.

Influences like these suggest that, lifted from the context in which they are naturally embedded, some events not only would not occur; they could not occur. Others would change dramatically. The keyword here is *embedded*, a condition unlike being plunked into Newtonian time and space or jostled about by mechanical forces. In various guises, context dependence is widespread. Nevertheless, settings, circumstances, conditions, and context in general continued to be ignored by the Academy. So-called special sciences such as psychology, sociology, and economics were even refused the label "science" precisely because of their context dependence.

* * *

To avoid becoming trapped in the historical baggage that the term *cause* inevitably brings with it, Juarrero (1999) relied on the concept of *constraint* to characterize the influence of context. As the next few chapters will describe, constraints are critical to coherence making. Autocatalysts and feedback loops, for example, produce long-range correlations and interweave patterns of matter and energy flow that display novel properties. And they do so as constraints, not mechanical impacts. This book will argue that interlocked interdependencies generated by constraints are the ground of coherent dynamics and their emergent properties. Moreover, constraints show that mereological powers and effects are real, bottom up, and top down, from parts to whole and wholes to parts.

This chapter introduces the general notion of constraint. Details of each variety of constraint are presented in the chapters that follow.

* * *

The late Canadian philosopher John Collier (2003a) identifies three prerequisites of complexity: a source of energy, *gradients*, and interactions that convert some of the energy influx made available by gradients to structure. ("Structure" includes "structures of process" [Earley 1981].)

Collier's first requirement is "a source of energy." It can be solar, geothermal, aeolic, hydraulic, chemical, biochemical, biomass, and so on. In the nineteenth century, the science of thermodynamics reintroduced the arrow of time, but it took the practical savvy of the Industrial Revolution to exploit constraints and extract work from energy flow for commercial purposes.

Harnessing energy is as important as the energy sources themselves; it allows energy to flow, and flow is necessary for order and structure to emerge. Collier's first requirement, a "source of energy," therefore implicates his second requirement, the presence of gradients, the first constraint.

In contrast to the concept of causation, the notion of gradients is unproblematic. The primordial gradient, cosmic expansion, originated with the Big Bang. On Earth, the ultimate source of energy gradients, of course, is the sun. Hydrothermal gradients near deep-sea vents are hypothesized to be sites where life on Earth might have originated. However, the full spectrum of energy is not equally available to all everywhere. Bats and dogs sense sound wavelengths that human beings cannot. Chemoautotrophs use energy from chemical compounds; photoautotrophs convert light energy to chemical energy. This major transition from anaerobic and extremophile microbes that rely on sulfate as their energy source to photosynthesizing cyanobacteria that produce oxygen was among the most significant of those innovations; had it not occurred, most plant and animal life would not exist.[1] The Industrial Revolution tapped fossil fuels; we do the same today with renewal energy sources. Microscopes, night scopes, telescopes, as well as computed tomography (CT) scans and magnetic resonance imaging, reveal energy spectra imperceptible to human senses directly. Different constraints that access different segments of the energy spectrum make a difference in the powers and properties they produce.

The second law is satisfied by the flow of energy along gradients. Transitions in cosmic, biological, and social evolution innovate by accessing new gradients, tapping new energy sources, and creating new information in the process. Since the early days of mechanical engineering, inclined planes are the textbook example of constraint. The steeper the slope, the greater their potential energy. Some natural gradients like cosmic expansion dissipate energy. Over time, the slope lessens and ultimately disappears. Cosmic expansion alone would quickly dissipate to thermal equilibrium without generating complexity. In contrast, nature's second gradient, gravity, is centripetal; it concentrates mass and energy. But gravity alone, too, would quickly implode in a massive black hole. By itself, neither cosmic expansion nor gravity produces coherence and coordination. Their coexistence throughout the cosmos, however, suggests the presence of other forms of constraints.

As understood here, then, gradients are only the first step toward coherence making and coordination dynamics. They are only one variety of constraints—*context-independent constraints*—to which the next chapter will be devoted. Other context-independent constraints such as buffers, isolation, and entrenchment will be explored in chapters 8–10.

Complexity formation therefore requires more than just a gradient; to evolve more complex dynamics, matter and energy must be coordinated and organized into coherent patterns (Bejan and Lorente 2004, 2008). It was only in the second half of the twentieth century with the advent of computer simulation (Abraham and Shaw 1992; Conway 1970) that science began to understand how coordination can tap and store energy in a way that isolated entities cannot (Nicolis and Prigogine 1977; Conrad 1972). Coordination harnesses gradients by capturing energy and converting it into persistent structure and order (Turvey 1990; Kelso 1995). Paradoxically, complex pattern formation in open systems far from equilibrium facilitates energy flow while simultaneously delaying heat death. Chapters 6–8 provide a detailed analysis of this process.

* * *

Collier's third prerequisite, interactions, can also be subsumed under the general idea of constraint. By interactions, complexity theorists mean relations other than the reversible bumping and jostling of Newtonian forceful impacts. Collier notes that self-organization is characterized by "unity relations," the information-carrying signature that signals a phase transition from unconstrained jostling to constrained coordination and order, such as the transformation from water vapor to the rigid structure of an ice crystal; from independent and separate photon streams into the coordinated alignment of laser beams; from algae and fungi to marvelous lichens; and from individual human beings to a distinct culture.

Constrained interactions leave a mark. They transform disparate *manys* into coherent and interdependent *Ones*. Constrained interactions, that is, irreversibly weave separate entities into emergent and meaningful coherent wholes. In doing so, they create and transmit novel information. That information is embodied in the coordination patterns formed by and embedded in context. Critically, coordination dynamics also leave imprints of the interaction on the interactants, which they change irreversibly. That imprint is new information (Shapere 1982).

The central question, of course, is What changes reversible bumping and jostling into *interactions that leave a mark—that create structure, order, and information*? The answer, just implied, is constraints, but in this case, a different type of constraint, context-dependent constraints (introduced in chapter 6).[2]

* * *

Coherence might be a better term for the unity relations of complex systems like snowflakes, tornadoes, lichens, living things, homeostasis, ecosystems, human practices, and cultures. Each of these is nothing other than a coordination pattern formed by different constraints with different stringencies, operating in different contexts. Critically, each of these overarching patterns is held together by a set of interlocking constraints; as a result, each displays qualitatively different emergent properties. Synchronization, coordination, and entrainment are instances of coherent organization, defined as a particular regime or logic of interlocking constraints. Coherence so understood marks a qualitatively novel form of organization and order that is absent in either isolated elements or clumped aggregates. Coherence is real; it is a relational and systemwide dynamic brought about by interdependence. All three of Collier's prerequisites therefore implicate constraints and constrained interactions.

The central insight of complexity theory is that constrained interactions among numerous variables in open systems in nonequilibrium can precipitate transitions to novel forms of order characterized by system-wide coherence, each with its own emergent properties. Coherence is not frozen and monolithic, block-like solidity. Complex order is a multiply realizable dynamic of constrained and constraining interactions. Elements in complex systems do not dissolve into a homogeneous medium or fuse into undifferentiated blocks. Rather, coherence consists of articulated and heterogenous interdependencies and covariances into which diverse elements are entrained and which now govern their behavior. Phrased otherwise, integration into coherent coordination dynamics is a form of generalization (Dean 2020, 36:40), a partitioning (Ladyman and Ross 2010) of reality into equivalence classes (Ellis 2016). Such coordination dynamics are contextually formed and multiply realizable.

Major transitions in evolution (Maynard Smith and Szathmary 1995) mark the generation of new coherences—that is, of new and overarching constitutive regimes that are the outcome of interlocking context-independent and context-dependent constraints. These contextually constrained interdependencies (Allen and Starr 1982) are best understood as *interactional types;* they enact covarying and interlocking constraints that embody qualitatively novel—because relational—information. Pointedly, as subsequent chapters will explain, because interactional types are formed through context-dependent processes, the information they carry and transmit is meaningful, not solely syntactical.

What are constraints and how do they generate coherent wholes? The next section delves more deeply into the general properties of constraints.

What Are Constraints?

Constraints are entities, processes, events, relations, or conditions that raise or lower barriers to energy flow without directly transferring kinetic energy.

Constraints bring about effects by making available, structuring, channeling, facilitating, or impeding energy flow. Gradients and polarities, for example, are constraints; others include catalysts and feedback loops, recursion, iteration, buffers, affordances, schedules, codes, rules and regulations, heuristics, conceptual frameworks, ethical values and cultural norms, scaffolds, isolation, sedimentation and entrenchment, and bias and noise, among many others.

Some of the consequences of constraints are *vectorial*. Gradients, such as those of electromagnetic fields and complex attractors, for example, guide energy flow in a particular direction. Computer settings, the interfaces of eardrums and cell membranes, and buffers and scaffolds all filter and select input such that energy flow is facilitated, directed, impeded, accelerated, harmonized, integrated, and so on, in one direction rather than another. Filters and interfaces that select inputs to an open system are also constraints. They do not directly transfer energy; instead they establish the context and conditions in virtue of which energy flow is possible, eased, accelerated, impeded, standardized, harmonized, channeled, directed, and otherwise influenced. Catalysts that promote or impede the integration of previously separate energy streams also affect the speed and direction of reactions. *Feedforward* and *feedback loops* use directionality to import the world into the very interdependencies and covarying relations they weave.

Spatial and Temporal Constraints

Constraints can coexist at a variety of scales and dimensions. They can be spatial or temporal, and both can simultaneously interact to influence how particular events change. Temporal and spatial constraints often "go without saying." And ignored.

Spatial configurational and design constraints are better known. The length of a playground's seesaw in relation to the height of its base establishes distinct background constraints on where the children must sit given their weights. These constraints must be simultaneously satisfied if the children are to see-saw at all. Spatial constraints turn the likelihood of *this entity here* conditional upon (and covarying with) *that entity there*. When constraints make place important, it becomes measured in terms of conditional probability.

Spatial constraints, that is, organize the world according to place or location. *Here*, *there*, *inside*, *out*, *up*, and *down* are all products of constraints that encode relational spatial arrangements and configuration as conditional probabilities. Embryogenesis is guided by spatial constraints. Given the location of a cell in a fertilized egg, it is more likely to develop into a muscle rather than a nerve cell. Organized spatial configuration is thus the outcome of constraint-induced symmetry breaks that configure reality into local, internally coherent and noncommutative types of entities governed by distinctive constraint regimes. Novel properties and powers emerge as a result.

These features are unexpected—downright bizarre, in fact—according to standard physics where, as noted earlier, time is reversible, and space is a featureless container. The features would be impossible if events are separate and do not interact.

In analogous fashion, principles of symmetry in Renaissance architecture stipulate that architectural features like turrets be placed in certain locations, but not in others, with some locations being more likely than others. Templates, blueprints, and scaffolds are other enabling constraints that assist in bringing about configurations or designs in space. Their constraints make possible or impossible, and direct, facilitate, or retard energy, matter, and information flow.

The term *spatial* will be used loosely throughout this book to include psychosociocultural situations such as economic conditions and social activities, as well as those physical, material, chemical, and biological conditions in which events and processes take place. A culture or community's traditions, as well as its morals and values, likewise specify activities that simultaneously constrain the attitudes and behaviors of members of that community. They specify where and how social practices must be performed.

Constraints that specify the exact sequence in which events must occur are temporal constraints. The term *temporal* can refer to interlocking constraints operating simultaneously at many time scales, cosmic, historical, evolutionary, or developmental. Temporal constraints make the likelihood of one event conditional upon one or more earlier ones. They include, for example, those interlocking constraints that span a species' lineage and an organism's genome and epigenetic profiles to guide development.

Adding temporal constraints to spatial ones immeasurably increases the potential for evolving greater complexity and an expanded capacity to evolve. And yet, despite their ubiquity in biology and human practice, temporal constraints in cosmology, physics, psychology, medicine, sociology, and ecology might be even less understood than spatial constraints. Circadian and seasonal cycles of constraints on metabolism and endocrine processes point to an important role for time in biology and medical interventions. Dismissed as unscientific not so long ago, however, chronobiology and chronopharmacology are only now being studied more rigorously.

Timing athletic training to estrogen and progesterone oscillations during the menstrual cycle, for example, appears to offer significant improvement in performance. Recently, oncology has also been studying the phases of tumors to determine if *chronochemotherapy*, timed in accordance with those phases or administered at a particular time of the day, might control tumor growth more effectively (Sancar and Van Gelder 2021). Bird, turtle, and salmon migration patterns are likewise calibrated to the progression of seasonal cues. Timing mismatches between annual migrations of birds and caribou on the one hand and on the other, those of plant sprouts or prey they feed on are examples of temporal constraints in action. As I write this, seventeen-year cicadas have come out of hibernation in certain regions of the United States. The constraints that enable and govern these unusual, thirteen- and seventeen-year cycles of the nineteen broods of periodic cicadas found only in North America are not yet fully understood.

Temporal constraints are at the heart of algorithms and protocols. Constraints themselves can concatenate: the activation of one constraint can become conditional upon the occurrence of an earlier one, for example. The general logic can be characterized as follows: given that X occurred, Y becomes necessary, impossible, or more or less likely. Given that X and Y have occurred in sequence, Z becomes overwhelmingly likely. Thinking of suffixes like -TION when playing hangman helps. Given -TIO, N becomes overwhelmingly likely.

As temporally constrained (not just haphazardly chunked) units, sequence of steps can bring about a degree of metastability that individual steps, performed alone or in a different order, cannot. Changing the order in which the steps of a recipe or an algorithm occur, or the duration of the interval between steps, changes the outcome. In consequence, entire sequences of events can themselves become organized units whose effects are qualitatively different from nonsequentially constrained events. The entire sequence itself changes the possibility space in which it occurs by becoming a constraint on subsequent events.

Childhood development is strongly influenced by temporally coded constraints. Studies of the effect of trauma in children indicate that there is a window of opportunity to correct negative consequences: those placed in healthy foster homes by age two showed cortisol levels like those of controls, but those placed in foster homes after age two produced less cortisol and showed a blunted stress response (*NewScientist*, February 22, 2020). (Normal myelination is likewise negatively affected by trauma that persists after age two.) As an example from a different domain, constraint regimes are also an important subject of research in clinical administration (Zhou et al. 2005), where hospitals specify postdischarge clinical instructions conditional on earlier sequences of inpatient events.

Temporal constraints are present in nonliving things as well. Surprisingly, sequential order that makes a difference has been found even at the quantum level: Heisenberg's matrices showed that different outcomes will occur depending on the order in which even quantum operators are implemented (Rovelli 2018; Barbour 2020; Halpern 2020).

In biology, time-dependent constraints support the evolution of taxa such as prokaryotes, archaea, and eukaryotes along temporally constrained as well as anatomical axes. Hominidae, *Homo erectus*, Denisovans, Neanderthals, Cro-Magnons, and *Homo sapiens* become "phylogenetically historical individuals" differentiated by distinctive interlocking context-dependent constraints, especially temporal ones.

Spatial and temporal constraints intertwine. Some constraints are hybrid—that is, their influence spans both where and when. In the biological realm, the genetic code is the preeminent example of *spatiotemporal intertwining*. Gene expression and regulation of developmental stages are instances of spatiotemporal constraints at work. We noted earlier that cellular differentiation in early embryogenesis, for example, is conditional upon the cell's location in the fertilized egg. There is also recent evidence that phenotypic effects of genetic mutations are conditioned by earlier epistatic interactions, those where the effect of one gene is suppressed by the effects of a different already active gene. Since selection operates on phenotypic traits, we can conclude that history plays a significant role in the direction of evolution.

Even in the genome itself, messenger RNA (mRNA) molecules encode a set of instructions for how to assemble a protein by arranging amino acids in a certain order, given certain conditions. What mRNA encodes, if you will, is a schedule, a set of temporal constraints that establishes the order and context in which other cellular processes must assemble amino acids step by step. Critical to cell differentiation and ontogenesis in general, then, regulatory and modifier genes arrange and time the expression of structural genes, moment-to-moment, site-by-site

Analogously, cultural and religious constraints structure social space through prescriptions, proscriptions, taboos, and rituals. In human societies, many of these constraints involve food preparation and eating. Deuteronomy's proscriptions concerning preparing and eating meat and dairy products together might well have originated as health-related constraints. To ensure that they are strictly adhered to, constraints with potentially serious outcomes often become entrenched as religious commandments and sociocultural rituals. To remove cyanogenic content from the cassava root and make it safe to eat, it must be prepared and cooked in a precise sequence of steps. These prescriptions transformed into religious practice for the Indigenous Tukanoans in the Colombian Amazon (Henrich 2016). The relation of practice to food safety might be forgotten, but Tukanoans follow the proper sequence for cooking cassava . . . well, religiously. These examples of constraints highlight their power to effect change in believers. Constraints are not epiphenomenal.

Timing is a temporal constraint. Seesaws were mentioned earlier; now consider playground swings. No matter how hard a child kicks, or how often, to increase swing height, what matters is when the child kicks. If they get the timing wrong, the swing will not swing. In addition to the kinetics involved, much of playground swing dynamics is a matter of timing, being or acting at the right place at the right time. In another example, research shows that gymnasts performing a full circle on a high bar are more likely to complete the 360° loop the later they inject energy into the swing from shoulder, hip, or knee (Irwin et al. 2021). Jazz syncopation is an interesting case in point: is it a complex constraint of musical composition, or is it instead a violation of a temporal (rhythmic) constraint?

Timing is just as critical in medical care, where context dependence is everything. Failing to administer CPR in a timely fashion, or withholding orange juice from patients in a diabetic coma brings about death as surely as a lethal injection. If the orange juice is consumed too late, the diabetic patient might well survive but will remain in a vegetative state.

Navigating by sound would be impossible without precise timing. Coded in terms of temporal relations (the interval length and pitch between two sounds), the timing code of our hearing system allows us to determine not only where sounds are coming from but also how quickly the source will reach us. (The code is much more precise in owls, which rely on it as they swoop down to catch a scurrying mouse [Humphries 2021].)

Because of modern science's dismissal of temporal constraints, the classical Greek notion of *Kairos*, appropriate timing, has been lost to science. The plots of many Greek plays often turn on the violation of Kairos. In contrast, the Newtonian state of mind focuses exclusively on *Chronos*, the allegedly objective clock-time understanding of time. But, as the three-body problem of planetary motion mentioned earlier teaches us, thinking in terms of one size fits all laws can be . . . well, inappropriate. This is particularly true concerning actions pertaining to legal issues, morals, and medical interventions; unlike eclipses, these are eminently context dependent and must be performed *pros ton kairon* (as the occasion requires). Future chapters will argue that the flexibility to engage in appropriate (not hardwired) behavior at the right place and the right time evolved because it provides survival advantage.

As is well appreciated by ecologists and social scientists, the more contextually dependent the system, the less explanatory universal laws like Newton's will be. Developmental biology is acutely aware of the spatiotemporally constrained nature of ontogenesis. But, except for the role of *inertial frame* in relativity physics, contextual constraints have not been central to our conceptual framework about cause–effect relations.

Context has been marginalized from much of physics and philosophy. Pun fully intended, it is time to bring it back by making room for the idea of effective science, principles that support counterfactuals within specified spatiotemporal contexts (see chapter 14).

Once again, a central theme of this book is that constraints are not efficient causes. Timing the kick does not impart additional energy to the swing over and beyond the kick itself; neither does the exact spot where the child sits on the seesaw. Because it is not a thermodynamic process, timing is not subject to conservation laws. How constraints bring about effects therefore avoids charges of overdetermination and violation of physical closure.

* * *

By precipitating symmetry breaks and making entities and processes covary conditional on each other, constraints turn possibility spaces irregular. Constraints sculpt a rugged and multidimensional landscape, the possibility and probability space of what can happen at all, what will most likely happen, and, when it cannot, can or must happen. This possibility space can be conceived on the analogy of an epigenetic landscape (see chapter 4). The conditional probability of individual events changes because their constrained interactions deform possibility spaces and thereby bias what can and cannot happen next, what and when it must happen, and so on. Depending on their weight, children must sit at the right spot on the seesaw for it to seesaw, kicks on swings must be performed at the right moment, and a gymnast's timing means the difference between success and failure. The coordinates and boundaries of a constrained space are encoded as probabilities: event with probability 0 = beyond that possibility space.

Analogous to the way spacetime curves and becomes a gravitational influence, spatiotemporal constraints transform possibility space into a rumpled canvas that can subtend subjectivity and the view from here and now. When coordinates and topology deform in response to constraints, place and moment suddenly matter. The view from inside a trough is different from the view from a hilltop. By warping possibility space in this fashion, local spatiotemporal constraints therefore also underpin the emergence of perspective and subjectivity. The view from my here and now is not sub specie aeternitatis.

Because numerous constraints must be continuously satisfied on many dimensions and time scales simultaneously, possibility spaces also reconfigure moment by moment in response to those multiple constraints, entrenched as well as current new ones. Possibility spaces are thus defined by their probability contour (Buchler 1977) or dynamic signature (Kelso 1995). I call it its profile.

From the perspective presented in this book, then, possibility spaces are not solely epistemic; they are real, bounded, and sculpted by constraints. These can be physical, chemical, linguistic, axiological, psychological, sociocultural, ecological, and so on; all can coexist or not, depending on the demands of multiple constraint satisfaction. Constraints encode the statistics and the meaning of the world in which a given complex system is enmeshed (Humphries 2021). They render contextually constrained relations path dependent. As a result, history and context continue to shape today's possibility spaces, in biological lineages, ontogenetic development, cultural traditions, and individual actions. As an example, the fact that no new phyla have appeared since the Cambrian explosion suggests that boundaries and coordinates of biological possibility space became sedimented during that period; it suggests the presence of very entrenched constraints. On the other hand, the emergence of oxygen-producing bacteria changed the entire constraint regime of the planet; this shows that emergent entities can and do modify the canvas in which events play out as much as the landscape influences the individuals' opportunities. Complex systems are not puppets.

* * *

This chapter described constraints in general, setting aside for the moment the differences between context-independent and context-dependent constraints. The next chapter focuses on context-independent constraints. Context-dependent constraints such as catalysts and feedback will be in the subject of chapters 6 and 7.

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