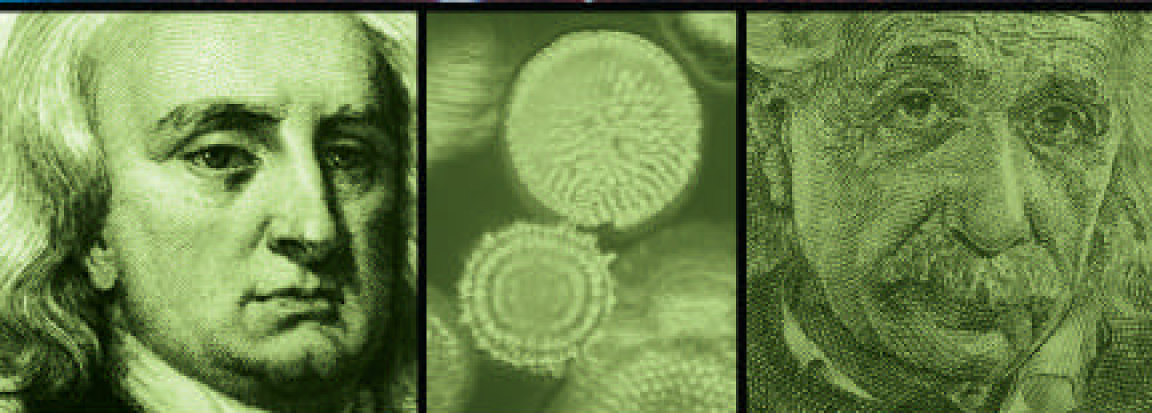
THE SCIENTIFIC WORLDVIEW



Beyond Newton and Einstein

Understanding the Universal Mechanism of Evolution

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Director, Progressive Science Institute

The Scientific Worldview

Also by Glenn Borchardt

The Ten Assumptions of Science

The Scientific Worldview

Beyond Newton and Einstein

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A limited edition of *The Scientific Worldview* was published in 1984.

I dedicate this book to:

Marjorie, Arnold, Bertha, Coutchie, Roger, Marilyn, Jim, Marion, Francis, Rod, Moyle, Art, Elizabeth, Dennis, Elia, Nina, Hasu, Chuck, Doug, Karl, Harry, Edward, Fred, Bob, Tom, and Natalie.

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Preface

The idea for this book was conceived on August 11, 1977. I had been reflecting on E. O. Wilson's comments during a television program on sociobiology. It all seemed so absurd. Wilson talked of human behavior as though it could be passed biologically from generation to generation, as though behavior was a thing rather than an interaction between things. Had I not been reading B. F. Skinner, of behavior modification fame, as well as certain nineteenth-century writers, I probably would have gone along with Wilson.

Like most scientists, I had been trained to follow a thoroughly modern scientific approach to every problem that came along. I seldom referred to what I was doing as anything other than "science" or the "scientific method." Few of my colleagues called the philosophy behind what we were doing by its correct name: systems philosophy, which I have since learned is the twentieth century scientific worldview. Like Wilson, we had been trained to study one part of the universe at a time. It was simply too big for any one person to study all at once. In the interest of efficiency we drew imaginary boundaries around portions of the universe, called them "systems," and, most important, pointedly and completely ignored everything else.

By emphasizing the influence of environment in controlling the behavior of "systems," Skinner and company avoided what has now become almost a global bias. In extending systems philosophy beyond its capabilities, Wilson unintentionally triggered within me a synthesis of nineteenth and twentieth century thought. I had spent fifteen years as a scientist before, on this day, I finally realized that it was neither the system itself, nor the environment itself that determined events. Instead, both acted together as a totality: the univironment (yū'nə-vī'rən-mənt), the word I was later to use for explaining this fundamental reality.

The univironmental idea had an intense personal impact. In my experiments I had always considered myself outside the reactions I was observing. Now I was a crucial, historical part of them. My physicochemical model of the world ran wild. For more than a week I was in a fatalistic daze as I thought, still somewhat narrowly, but certainly not conventionally, "We are all chemicals and all our behaviors are chemical reactions." This was a giant, if somewhat clumsy, step outside systems philosophy. In this new way of thinking, whether we consider ourselves chemicals, systems, microcosms, or just plain folks made little difference—all are influenced by both the within and the without. Behavior was simply the motion of one portion of the universe with respect to other portions. This simple yet profound conception was radically different from anything I had known. The dictionary didn't even have a word for it. I gradually recovered by savoring the newfound perceptiveness. I would never look at anything in the same way again.

Now I would like to convey a bit of that awe and excitement. I sincerely hope that you find this book stimulating and that it will hasten you on your own path of discovery. The subject at hand has presented plenty of opportunity for that, as you will see. All along the way, I have chosen sides. Not being a believer in free will—that is, uncaused human thought and action—I have often asked myself, "Why have I chosen thusly?" The reasons may become clearer as the sources of my ideas are revealed in the documentation of the text. The main thrust, I find, though, is derived from dialectical materialism, the philosophy that comes closest to achieving the univironmental balance under which I am sure the world operates. This, in turn, has yielded to what seemed to be the practical necessities of the scientific method as I learned it in the United States during the '60s and '70s. As a scientifically oriented student of dialectical materialism, I have been perplexed to find that its primary assumptions are mostly implicit, not explicit. But like the empiricists before them, dialectical materialists seemed to be supercautious about setting up new absolutes that would result in an unchanging dogma. The resulting vagueness might be useful for achieving certain political goals, but it does not allow a quick grasp of the philosophy. Dialectical materialists followed tradition in their tendency to ignore the metaphysical foundations of their method. By metaphysics I mean "beyond physics," not in the supernatural sense, but in the sense that the fundamental assumptions underlying any philosophy are not fully testable. For example, the assumption of *infinity* is derived from experience with the outside world, but no one will ever travel to the "end" of the universe to check it out. At some point we are faced with a choice between opposing assumptions. Let us choose assumptions that lead to scientific, rather than religious, conclusions.

The starting point for dialectical materialism was the philosophical opposition between materialism and idealism. The same argument can be viewed differently and contained as well within the determinism-indeterminism antithesis without developing the customary antagonism toward idealization. In practical scientific work, idealism is as necessary as indeterminism is unnecessary. Science has continued to be a successful model-building process despite the opposition to the reduction of all things to matter in motion. The process of reducing the infinity of qualities we find in the real world to just a few in the ideal world is evidently useful despite its inherent failings. Instead of eschewing models, we should insist they be brought out of isolation.

As a typical scientist trained in the United States, I was furnished with wonderful tools for completing my tasks. Not a word, however, was mentioned about the fundamental assumptions I was making as I carried out the work. Sure, there were inklings about causality and teleology. There were debates with liberal arts students in which we proto-scientists seemed to gravitate toward the side that rejected free will. But an experiment was an experiment; it seemingly did not make any difference what you were thinking when you did it. The curriculum had no room for philosophy, which was then taught as a confusing smorgasbord guaranteed to insult the fewest students and benefactors. Our scientific mentors dimly perceived such "philosophy" to be more hindrance than help.

After all, the key to a successful scientific career seemed to involve sticking to a particular specialty, applying for and getting grants, and avoiding theories outside your field. I could do this well enough, but I kept getting sidetracked. The universe was such an exciting place! The more I studied outside my field, the more uncomfortable I became about the party line. Imagine! Really smart people were telling us that the whole universe exploded from a point smaller than the period at the end of this sentence. I simply couldn't believe it. How could one get serious about such an absurd idea?

As it turned out, the answer was simple: GIGO. Garbage in; garbage out, as the techies say. With the Big Bang Theory, scientists barely realized they had gotten themselves knee-deep into philosophy. If nothing else, they had proven once again that it doesn't make any difference how smart you are if you are given the wrong tools to work with. But in science, as in logic, if you don't like your ending point, you need to reexamine your starting point. This book is such a reexamination.

Big Bang theorists, of course, would not agree that a reexamination is necessary. After all, they *like* their ending point. The media and the funders apparently like it even better. Adherents certainly don't think that the Big Bang Theory is "absurd." It fits their philosophical beliefs, which, as demonstrated in this book, really are not all that scientific. Science has been forced to develop within a world dominated by mysticism and religion. Within the scientific community as well as in the greater society there is a continuous philosophical struggle between "determinism" (the belief that all effects have material causes) and "indeterminism" (the belief that some effects may not have material causes). It is my opinion that scientists must be overt determinists. Part of the philosophical struggle, however, is with those who deny that the struggle even occurs or that it is a meaningful activity. They certainly would not be writing a book that contains *The Ten Assumptions of Science*. They are not bothered by the compromises that have produced the absurd notion that the entire universe is a system without an environment.

The first edition of *The Scientific Worldview* was very much a product of the progressive movement of the '60s. Its completion in 1984 faced a global rightward shift and anti-intellectual vacuum from which we still suffer today. The capitalist triumph over communism led to despair among idealistic intellectuals who had hoped that international cooperation would progressively trump international greed. Of course, whether one calls it "imperialism" or "globalization," the process continues unabated. The frightening confrontation between dialectically opposed superpowers now has been replaced by a multitude of religious wars.

In the United States, this confrontation has taken the form of a relatively peaceful "cultural war" between the red and blue states. Today, the conflict between the religious assumption of ***creation*** and the scientific assumption of *conservation* is touted as the battle between "intelligent design" and evolution. But, as assumed in this book, the universe is infinite. It exists everywhere and for all time. The universe had no beginning and will have no end. We need not hypothesize a God, and then be stuck with that logically inconvenient question, "Who created God?" What the creationists mistake as intelligent design is merely the workings of the universe; all things evolve with respect to all other things. The infinitely vast universe continually produces an infinite number of possibilities, but not a single impossibility. There is no "design," intelligent or otherwise; what works, works.

The current attack on science ultimately will fail because one cannot study any part of the universe properly without considering its evolution. Education without evolution is vacuous. We spend billions on education so that our children will be able to negotiate their ever-changing, evolving environments. We fill their heads with ideas and then they do the scientific thing—they test those ideas in the external world. Their very survival depends on the truth: ideas supported by interaction with the external world.

This book covers a lot of philosophical and scientific ground in a short time. I have written it primarily for young scientists and philosophers who will be overthrowing many of the silly theories that my generation has fabricated. I hope that you find it thought provoking and that it benefits your future work immensely.

I wish to thank all those who kindly supplied deterministic criticism during the preparation of the manuscript, especially Marilyn Borchardt, Roger Burbach, Andy Kahn, Peter Luft, Elizabeth Patelke, Steve Walter, and many others. I am grateful to those teachers and colleagues who were a constant source of inspiration during this pursuit. Although no government or foundation funds were used

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Berkeley, July 28, 2006 Glenn Borchardt

Chapter 1

Introduction

> The question of questions for mankind—the problem which underlies all others, and is more deeply interesting than any other—is the ascertainment of the place which Man occupies in nature and of his relations to the universe of things. Whence our race has come; what are the limits of our power over nature, and of nature's power over us; to what goal we are tending; are the problems which present themselves anew and with undiminished interest to every man born into the world.[1]

We are all scientists. Life presents us with one problem after another. Each day, we concern ourselves with cause and effect. Each day, we speculate about the reasons for the actions that surround us. We believe that certain actions produce certain effects. Whenever we depend on finding a relationship between cause and effect, we demonstrate belief in causality. To the extent that we believe that causes must be real, material aspects of the world, we profess the philosophy of *determinism*.

But there is an opposed philosophy, *indeterminism*, the belief that some effects may not have material causes. We are born indeterminists, knowing little of the causes of effects. It is only by interacting with the real world that we become determinists, in essence applying the scientific method to all aspects of existence. As we grow, we discard ignorance based on superstition for knowledge based on experience. The process necessarily involves a perpetual conflict between these two ways of viewing the world; each person and each society professes a philosophy containing elements of both.

Once again, the time has come to examine determinism and indeterminism in a systematic way and to choose wisely between them. The compromises with indeterminism that scientists have concocted since the nineteenth century are getting stale; they are becoming an impediment to progress. Cosmologists have become cosmogonists, naïvely assuming and unabashedly promulgating the ancient idea that the universe itself had an origin, even though the creation of something from nothing is a religious assumption, not a scientific one. Physicists say that gravitation is due to the "curvature" of "spacetime," but we have trouble imagining how either of these could be. Chemists claim that the universe is becoming more disordered each day, implying that it will eventually end in chaos. Most of our citizens are still enamored with occult beliefs ranging from the psychic to the astrological. From a strictly scientific perspective, our efforts to appease the religionists have borne strange fruit indeed.

To put science and philosophy back on track, I propose a reopening of the debate between science and religion, which I present here as the struggle between determinism and indeterminism. To be gained from this new rift is a better understanding of the necessarily elusive foundations upon which we build our thought and interpret the external world. To be gained is an improved, internally consistent, and scientific way of viewing the world. Any step in this direction would help us control the technology our culture has spawned.

Each new gadget usually comes with a set of instructions or "philosophy" for its use. It would seem that the modern, scientific world that we are building would require a scientific philosophy for its safe operation. Yet according to Victor Ferkiss, author of *Technological Man*, "Little evidence exists that any scientific worldview is taking over the integrating function in our culture, or even that such a worldview is commonly shared by those who call themselves scientists."[2]

The reason for this state of affairs is that the Scientific Worldview is determinism, but the philosophy of our culture is overwhelmingly dominated by indeterminism. Despite its great achievements in research and engineering, the scientific enterprise remains too weak to defend itself against the pervasive power of indeterminism.

Science does not develop in a vacuum. It always reflects the culture from which it grows. That an indeterministic theory such as the "Big Bang" theory of the origin of the universe is taken seriously by most scientists, popularized by the media, and accepted by most of the public, provides a clear illustration of the reciprocal relationship between science and the philosophy of the culture. A change in one produces a change in the other.

Science advances, not just by efforts within the profession, but equally by the philosophical and practical advances made by all members of society. You are part of the environment in which science is performed. What you say and do helps to construct the science as well as the society in which you live. Regardless of your profession, your understanding of the Scientific Worldview will aid in scientific discovery.

While much of what represents science these days is little more than curious trivia, the Scientific Worldview is not. Indeed, when problems mount and stress increases, societies reexamine philosophy with a renewed fervor. First they turn to the familiar indeterministic ways, but because those ways do not, in the end, succeed for the great mass of humanity, they eventually look to the philosophy of determinism. When push comes to shove, when survival is at stake, the philosophy of indeterminism fails us. Prayers do not stop bullets.

Scientists survive professionally by determining cause and effect. They must be determinists, at least within their specialties, or else they cease to be scientists. If you believed that a certain effect had no material cause, then you would not be motivated to look for a cause. You would then cease being a scientist in that area of investigation.

Although scientists may be determinists within their necessarily narrow specialties, they receive little encouragement to be determinists outside them. For scientists to extend publicly the principle of causality to the point of universality, they must risk being seen as foolhardy or arrogant. There also is little agreement on just what determinism is and in what way it could be said to be the exclusive basis for the Scientific Worldview. Those who should know, the experts on the philosophy of science, take care to avoid the label "determinist" lest they be banished from academe.

Discovering the nature of the Scientific Worldview is no easy task. It cannot be found by summing all scientific specialties, or by polling scientists and averaging the results. The Scientific Worldview, above all, must state its beginning assumptions clearly and from there attempt a coherent unification of the salient facts and a rigorous application of determinism to the world as a whole. It would not be in agreement with every interpretation advanced by every specialist. No explication of it would be accepted by all scientists.

Throughout history, the idea that the universe is governed strictly on deterministic principles reappears embellished with a style and with facts reflecting the culture it addresses. Each time, efforts are made to refute it. Eventually it is suppressed, only to return stronger than before. Humanity today appears to lie at the threshold of physical destruction. Its survival will not be a miracle, but a result of the deterministic actions we will take to forge a new unity among all peoples. The time is ripe for a renaissance of determinism.

Two other worldviews previously dominated scientific thought.

The first scientific worldview, Newtonian mechanics, provided a general, mathematical construct that, despite its overwhelming success, had a fatal flaw. It could never be completely successful because it was macrocosmic; that is, it overemphasized the outsides of things. Its preferred instrument was the telescope. For Newtonians, the universe was macrocosmically infinite, but microcosmically finite. Scientific theories based on the Newtonian worldview tended to be macrocosmic and fatalistic. Darwin's mechanism of evolution, for instance, became "natural selection," in which the environment dominated evolution and the organism was seen as relatively helpless in the survival of the fittest. Natural selection had little to say about why there was anything to select from in the first place.

The second scientific worldview, systems theory, was a corrective reaction to Newtonian mechanics. Modern systems theory invariably errs on the microcosmic side; it overemphasizes the insides of things. It tends to stake out a portion of the universe in the effort to study it to the exclusion of all that surrounds it. Its preferred instrument is the microscope. For systems theory the universe may be microcosmically infinite, but macrocosmically finite. Scientific theories based on systems theory tend to be microcosmic and solipsistic. Modern astronomy, for instance, entertains the quintessential systems theory, the Big Bang, in which the universe itself is seen as a solitary system with nothing outside of itself. All it required was the acceptance of Einstein's absurd assumption of a fourth dimension to satisfy those desperate to evade the infinite and all its philosophical implications.

Organization of the Book

This book consists of five parts: it states The Philosophy and its historical development, posits The Assumptions and their indeterministic alternatives, deduces The Method for viewing the world, develops The Analysis to criticize and to advance theories of the universe, and demonstrates the practical usefulness of explicit determinism in The Conclusions.

Part One, The Philosophy, considers all philosophies as deterministic in certain aspects and indeterministic in others. A brief sketch of the history of the determinism-indeterminism conflict is presented here as a progressive cycle of action and reaction. Only with new data and an analysis in which we once again see determinism and indeterminism as opposites can we continue to achieve significant advances in the evolution of the continuum.

Part Two, The Assumptions, explains why philosophical arguments seldom persuade the contenders to switch sides; their arguments rest on opposed assumptions. One either believes there are causes for a particular effect or one does not. One either believes that the universe is infinite or one does not. The basic assumptions of science are seldom made explicit in scientific work. Frequently there are two versions of each: one deterministic and the other indeterministic. The assumptions elaborated upon in this part of the book meet two criteria: First, is the assumption deterministic? That is, does it avoid a free will conclusion? Second, does it avoid contradicting other deterministic assumptions and the data of modern science? The resulting Ten Assumptions of Science (*materialism*,[3] *causality*, *uncertainty*, *inseparability*, *conservation*, *complementarity*, *irreversibility*, *infinity*, *relativism*, and *interconnection*) are interrelated and consupponible[4]—that is, it is logically possible for those who assume any one of them to assume all the rest.

Part Three, The Method, presents the primary abstraction necessary for a coherent view of the world. Instead of considering systems in isolation from the rest of the universe in the usual way, this method insists on their non-isolation. I begin by defining a microcosm as a portion of the universe and redefining a macrocosm as that portion of the universe outside of a particular microcosm. The univironment is that combination of the microcosm and the macrocosm that is responsible for the motion of the microcosm. This way of looking at things amounts to a new philosophy—Univironmental Determinism—which is at once the mechanism of evolution. Unlike natural selection and the currently accepted theory, "neo-Darwinism," Univironmental Determinism explicitly claims that evolution is the process occurring at all times with respect to each electron, atom, cell, organ, organism, species, ecosystem, planet, galaxy, and cluster. This perspective stresses the space-time positions of microcosms as the key to understanding evolution. In its practical form, the philosophy of Univironmental Determinism guides univironmental analysis, the human effort to produce testable predictions of the motions of microcosms by considering the motions of matter within their respective microcosms and macrocosms. It is through this method that the world is analyzed in the remainder of the book.

Part Four, The Analysis, shows how this approach can be used to evaluate current theories in cosmology, biopoesis (the origin of life), biology, and sociology. I show, for example, that the philosophical foundations of the currently popular theory of the Big Bang origin of the universe are clearly indeterministic. Being biased in its overemphasis on the microcosm, the Big Bang Theory is the archetype and culmination of "systems philosophy," the scientific worldview that has guided science since the beginning of the twentieth century. The argument predicts that the rejection of the Big Bang Theory and the establishment of its only logical replacement, the Theory of the Infinite Universe, will require and produce a revolution both in science and philosophy.

Part Five, The Conclusions, reviews the implications of Univironmental Determinism, first, in debunking a popular myth, and second, in exploring personal and social philosophy. The Myth of Exceptionalism is the indeterministic hypothesis that even if humanity did evolve from less complex beings, things are different now; certain aspects of its existence are no longer influenced by evolution. In relation to the current debate between determinism and indeterminism, one's position on exceptionalism is decisive. To reject the Myth of Exceptionalism is to reject indeterminism.

The last chapter shows how Univironmental Determinism confronts the doctrine of fatalism with which determinism is so often confused. The case for Univironmental Determinism as the Scientific Worldview is completed here and its utility as a guide to personal and social action is demonstrated. The Scientific Worldview not only helps us understand, but also helps us participate in the great movements of the Social Microcosm of which we are all important parts.

Objectives

The Scientific Worldview is filled with infinite richness and variety. No complete description of it ever will be given. Nevertheless, a basic understanding of this philosophy may be achieved through the specific aims of this book, which are:

1. To present the framework or skeleton upon which the Scientific Worldview can be built;
2. To argue that this framework must necessarily begin with the concepts of the microcosm, the macrocosm, and their relationships to each other;
3. To argue that the essentially dialectical nature of the universe reduces to fundamental and inseparable categories: matter and the motion of matter, concepts that are expandable to include all things and all events;
4. To argue that we are all scientists and to show how the scientific outlook derives from the fundamental assumptions of the Scientific Worldview;
5. To describe and demonstrate the rules for rejecting unscientific beliefs;
6. To give readers an overall impression of the world and their place in it, how it can affect them, and how they can affect it.

Part One

The Philosophy

Chapter 2

The Renaissance of Determinism

> So many phenomena formerly regarded as mysterious and even supernatural have yielded to scientific analysis that the person who argues that some particular phenomenon is impervious to scientific explanation in physical terms must assume a tremendous burden of proof.[5]

Those who can afford to relax—the inactivists—have little need for philosophical determinism, and mostly, they will tell you so. But those who can hardly spare a moment—the activists—are interested in making every action count. Today humanity is in a period of intense activity. A lot of adjustments have to be made in a very short time to avert disaster on a global scale. We must discover the causes for effects with an urgency that, in the past, was demanded only of small, relatively isolated communities. Once again, explicit determinism will be required for survival, but this time it must emerge as a global phenomenon.

What will this twenty-first-century version of determinism be like? What will be its prescriptions? What will be its proscriptions? And *really*, how can one be so sure that it will develop at all? We can begin to answer these questions by studying the history of philosophy viewed in its relationship to the material conditions under which it arose. We cannot get an adequate appreciation of the new philosophy without some consideration of its evolution out of the struggle between determinism and indeterminism. Throughout the book I will continue to emphasize the progressive nature and the necessity for that struggle, but in this chapter I present a cryptic historical sketch or cartoon, if you will, designed mostly to convince the professional scientists among you that philosophy is pertinent to your work.

The Philosophy of Philosophy

Among Western scientists, philosophy's long association with religion has tarnished its image and made it seem irrelevant to the scientific method. In fact, in the United States, one may achieve the revered title "doctor of philosophy" in the sciences without having taken a single course in philosophy. The formal discipline that calls itself the "philosophy of science" is generally ignored by scientific workers. Professional scientists who have examined this specialty find it to be "at best a series of brilliant axiomatic games, but often pretentious nonsense."[6]

Why is this? Does philosophy have nothing to offer science? Could it be that the philosophy taught in the United States is more of a hindrance than a help to science?

Everyone has a philosophy, but it often seems that scientists are the last to admit it. What Frederick Engels wrote over a century ago still applies:

> Natural scientists believe that they free themselves from philosophy by ignoring it or abusing it. They cannot, however, make any headway without thought, and for thought they need thought determinations. But they take these categories unreflectingly from the common consciousness of so-called educated persons, which is dominated by the relics of long obsolete philosophies, or from the little bit of philosophy compulsorily listened to at the University (which is not only fragmentary, but also a medley of views of people belonging to the most varied and usually the worst schools), or from uncritical and unsystematic readings of philosophical writings of all kinds. Hence they are no less in bondage to philosophy, and those who abuse philosophy most are slaves to precisely the worst vulgarised relics of the worst philosophies.[7]

To avoid the "worst" philosophy and to know the "best," we must have a philosophy of philosophy—a point of view from which to judge. But such judgment itself requires a philosophical choice: one must believe either that philosophy follows a pattern or that it does not. Those who believe it does choose with Engels and with Linnaeus, the famous taxonomist, who observed that "the first step in science is to know one thing from another."[8] This striving to judge, to clarify, and to reduce the infinitely complex to the simple and understandable is the first impulse of the scientific mind. It is undoubtedly a biased impulse.

Engels, Marx, and their followers classified philosophies on the basis of the opposition between materialism and idealism.[9] The question they saw as dividing all philosophies into opposing camps was, "Which is primary, spirit or nature?"[10] Their works constitute an answer to this question and a tremendously useful elaboration of the meaning of materialism and idealism. Today, however, that question is no longer as relevant as it once was; it even could be misleading. Scientists invariably use idealizations throughout their work. Thus, for example, it is sometimes necessary to think of matter as perfectly solid and space as perfectly empty even though the real world has neither. I think, however, that the battleground in philosophy needs to shift in a more radical way. Among the educated, the place formerly occupied by spirit has yielded to an equally mysterious concept: free will. To advance in philosophy, it is no longer enough to be a materialist; one must now become a radical determinist as well.

The Philosophical Continuum

Theoretically we could use any number of questions or distinguishing features for classifying philosophies. Also, according to the deterministic assumption of *relativism*, implicit in our first philosophical choice above, we would expect no two schools or philosophical camps to be identical. The various schools answer the paramount question in different ways, each expressing their answers in special languages and stating them in texts of varying length and quality. The differences between schools may be quibbling over insignificant details or they may be the beginnings of new philosophies.

To classify philosophies into particular categories is to ignore what may turn out to be important distinguishing characteristics. To refrain from classification is to ignore important similarities that may help us understand philosophy in general. There may be a recognizable pattern, but it certainly is not a simple matter of sorting philosophies into black and white categories. We do not expect to find any examples of pure materialism or pure determinism. As Engels argued, we still need to classify philosophies to understand them, but how can we do this and still do justice to their fine points?

The Reality

In the introductory chapter, I announced my firm belief that the universe is strictly deterministic, that all effects have material causes. There is only one reality, regardless of what anyone thinks about it.

The Ideality

Although there is only one reality, there is no end to the variations in ideas about that reality. There is even no agreement that there is, in fact, only one reality. But if one grants that the external world actually exists (more about this under *materialism*), then certain possibilities arise. Throughout its history, science has struggled to achieve the closest possible agreement between ideas of reality and what that reality actually is. Science, therefore, *does* have a way of judging between the best and the worst philosophies: it is the correspondence between reality and what we say about it.

If the universe is entirely deterministic, then the Scientific Worldview, based on our attempts to formulate ideas that correspond with reality, is the philosophy of determinism. In its simplest form, the paramount question "Do all effects have material causes?" divides all philosophies and all philosophers. A simple "yes" or "no" nicely distinguishes one as either a determinist or an indeterminist. The answers most people give, however, are "yes, but …" and "no, but …." The qualifications fill volumes.

In this book, I look on all of philosophy as an attempt to answer this question. There is a tremendous range in the quantity and quality of the qualifications and supporting evidence for each answer. Of course the answer to a question may be faulted as much for what it excludes as for what it includes. Theoretically, there are an infinite number of secondary questions that philosophy tries to answer. A philosopher or a scientist may give a correct answer to one and an incorrect answer to another, and thereby be called a determinist in one instance and an indeterminist in another. Thus I wish to state at the outset that when I classify a particular statement or philosophy as "deterministic" or "indeterministic," it is solely for the purpose of exegesis. It is my way of making my point of view clear. That judgment, too, must be seen in its proper context.

Like all classifications, the distinction between determinism and indeterminism is relative. We may have an idea of hot or cold, short or tall, north or south, or an idea of determinism or indeterminism, although we do not expect any of these to exist independently of the other. For a classification to have any meaning, there must be a referent. The complexity of philosophy, however, makes it impossible to include an appropriate referent with each judgment. The generally unstated referent that I use is of necessity the selfsame philosophy that I am about to elaborate throughout the book. There are hundreds of secondary questions implied in the text, and no one is going to answer all of them the same way I do. It is indeed unfortunate that many of my philosophical classifications probably will make sense to you only after you have read and understood the viewpoint I am propounding.

Although I frequently may give that impression in the pages to follow, I really do not conceive of determinism and indeterminism as distinct, absolutely separate categories. Rather, I think of philosophy as a continuum of opposing views. The determinism-indeterminism continuum is one of the simplest possible conceptions in philosophy, just as the left-right conception is one of the simplest in politics. Both philosophy and politics are filled with infinite richness that cannot possibly be completely contained in an abstraction of any sort, much less a linear one. Nevertheless, the idea of the continuum can provide the framework for building an understanding of philosophy. Without it, philosophy remains a mishmash of conflicting opinions without context and without a relationship to the person who tries to understand it.

An advantage of viewing philosophy as a continuum instead of rigid, disparate categories is that it forces us to define one viewpoint in relation to the other. Our conception of determinism clearly depends on our conception of indeterminism, just as our conception of "hot" depends on our conception of "cold." Each person expresses these concepts in different ways and means different things by them. To define determinism and indeterminism in terms of their respective views of material cause and effect, as I did initially, may serve to divide philosophy into two parts, but it does not provide a continuum. For this we must look to *cause*, *effect*, and *material*—words so profound that, as I will demonstrate shortly, there are theoretically an infinite number of possible definitions for them. Consequently, there are an infinite number of possible combinations of determinism and indeterminism. In a sense, all philosophies could be called *dualisms*, because all have characteristics that make them deterministic and all have characteristics that make them indeterministic.

This does not prevent us from using the terms to good effect, just as we are not prevented from using the terms *hot* and *cold* even though the same phenomenon may have been described by both terms in the past. To have meaning, *hot* and *cold* must be defined with each usage. As I said, the concept of determinism is so complex that this whole book is one definition—and necessarily an incomplete one at that. Moreover, since determinism can only be seen in relation to indeterminism, both philosophies must appear on stage at the same time. To make a distinction between these two great worldviews, we have no choice but to draw a line somewhere, to be divisive, even polemical. It is necessary to cut and hack our way through the philosophical and scientific underbrush to discover the differences between science and nonscience. The alternative, a scrupulously fair treatment of all philosophies, such as that attempted in some classrooms, would point out important facts about each and find none of them better or worse than the other. Such an approach might avoid philosophical conflict, but it is unlikely to discover the Scientific Worldview.

Progression of the Determinism–Indeterminism Spiral

Overall, the dialectical opposition between determinism and indeterminism is irreconcilable. It is only through the development of secondary questions inspired by concrete changes in the external world that the debate shifts toward an evermore deterministic philosophy. This observation is part of the struggle itself. Indeterminists, being on the losing end of the philosophical stick, would just as soon not be reminded of the long-term trend. Thus, along with trying to retard the development of philosophy, indeterminists have devised all sorts of ways to obscure the fact that progress has occurred at all.

There is plenty of opportunity for this obfuscation if one is so minded. While it is being propounded, one view tends to dominate the other. When the opposing view regains the floor, it tends to dominate. The result is a historical cycle akin to the one in politics in which the rise of the left follows the rise of the right, and vice versa. There are two fundamentally opposed viewpoints concerning the question of long-term trends in cyclic behavior. In what I call the indeterministic view, no really long-term changes in the cycle are recognized. In the philosophy of science, one of the most influential versions of this view was that of Paul Feyerabend's *epistemological anarchism*.[11] The upshot of Feyerabend's line is that no one of the various schools of philosophy is more *correct* than the others. It is granted that one view may have more political strength than the others at any moment and that there are changes in philosophy, but there is no progress. A corollary of the theory is that the determinism-indeterminism debate is pointless. Over the long run, it makes little difference which philosophy one chooses. The strict empiricists and our career counselors in science were right; philosophy is irrelevant.

In the deterministic view, permanent, irreversible changes occur with each cycle. The cycle in philosophy, like all real cycles, is really a spiral. That is, there is a progression. The scientific explanation of progress is quite involved and will be developed throughout the book. Briefly, it involves the negation of the concepts of perfect isolation, equilibrium, and reversibility. For a long time it was thought that these idealizations were accurate descriptions of the real world. Assuming that philosophy is a part of the real world, the only way in which philosophical cycles could be completely reversible and thus *not* progressive would be for them to occur in perfect isolation, the condition necessary for perfect equilibrium and perfect reversibility. As we will see, many indeterminists still hold out for such perfection. In their insistence that perfect isolation is impossible, determinists imply that perfect reversibility also is impossible.

The reason the progression favors determinism rather than indeterminism may be sketched briefly from a similar argument. Let us assume that philosophy is an internal or ideal assessment of the external or material world. In that case, a philosophy conceived in perfect isolation, independent of the external world, would be a philosophy about nothing—it could not exist. A philosophy conceived in perfect nonisolation, dependent on contact with all portions of the universe, would be a philosophy about everything; it too could not exist because such perfect contact with all things is impossible. In reality, all philosophy exists in a relative, not an absolute or perfect isolation. By denying that some effects have causes or even that the external world exists, indeterminism reveals its association with the actual, physical isolation of its philosophy. Determinism, on the other hand, presupposes the existence of the external world and depends on the discovery of the causes of effects for its justification. The more philosophy interacts with the external, material world, the more it leads to the discovery of causes for effects, the more it reveals its reliance on actual, physical nonisolation.

What the "epistemological anarchists" and other indeterminists fail to recognize is that the evolution of humanity has followed a pattern of decreasing relative isolation. The population has grown to explore and to exploit the far reaches of the planet and even other parts of the solar system. Both the quantity and the quality of these examinations of the external world have increased and improved throughout history. The expansion and communication of knowledge inevitably pull philosophy out of the hands of indeterminists. The brain has always been in contact with the external world, but today the accessibility of the external world is unprecedented. The philosophy of determinism thrives on this interaction, while the philosophy of indeterminism thrives on isolation. When that isolation is broken, a "cultural war" ensues.

Even the nature of debate itself serves to advance the progression of the philosophical continuum. Prior to a debate, opposing sides exist in separate, relatively isolated circles, comfortably resting in the supposed certainty of their positions. When the dialog actually begins, the relative isolation of the opposing sides is broken and each side is in danger of losing adherents simply because only one view best fits the wider perspective that is opened by the debate. Growth occurs on the part of both sides because each is forced to examine the external world as it searches for support for its beliefs. Thus, the fact that there is debate favors determinism. It is impossible to debate without becoming less isolated and thus learning more about the external world.

The determinism-indeterminism spiral progresses because philosophers in each era have more and better data to consider in their theories. Imagine what it must have been like a few thousand years ago when the most advanced discussions involved whether the god of lightning was male or female, or whether fire was matter or spirit. Today's philosophers are forced to keep up with the latest scientific developments. No modern philosophy, even an overtly indeterministic one, can afford to ignore the issues behind the laws of thermodynamics, quantum mechanics, relativity, and the implications of the galactic redshift. The philosophical continuum advances because knowledge advances and even the most extreme determinists of the past are considered indeterministic in certain respects today.

I have chosen to represent the cyclic-progressive changes in the determinism-indeterminism debate by selecting nine philosophers who illustrate the extremes and the compromises characteristic of the philosophical continuum. The curt descriptions below do not do full justice to these philosophies, of course, but at least they demonstrate an interpretation guided by the assumption that a spiralic progression has occurred.

Determinism Gets a Voice: Democritus and Atomism (Fifth Century BC)

We pick up the debate in Greece, where, according to C. S. Peirce,[12] the first clear enunciation of determinism was made by Democritus. Prior to this, of course, deterministic elements of philosophy abounded in people's lives, but without an advanced, abstract conception of matter, determinism was overshadowed by indeterminism. Democritus's philosophy, atomism, taught that everything in the universe was made of indivisible atoms whose behavior, in principle, could be perfectly described by a finite set of laws. It was this line of thought that eventually led to Newton's classical mechanics and the modern theory of the atom. In the hindsight developed from scientific assumptions that I will explain later, it is clear that the deterministic elements of atomism included the ideas that limited knowledge could be used to form universal generalizations, that matter is continually in motion, and that matter interacts with other matter in ways that can be described by causal laws. The indeterministic elements of atomism included the notion that matter was ultimately indivisible and the idea that perfection was possible in reality.

Indeterminism Imagines Reality: Plato and Idealism

All in all, atomism wasn't a bad start. One might ask: why didn't philosophy just take off from there and develop determinism as a straight-line function of expanding knowledge? Why regress to indeterminism if determinism is the correct view? Advanced ideas arise in those sectors of civilization that are thrust into contact with newly developing aspects of the external world. This, too, is a relative isolation, but it is different from the relative isolation experienced by society as a whole. When new ideas are released from this relative isolation, they must confront old ideas whose existence has proven their usefulness for past conditions. Thus, barbarians in the hinterlands certainly could not embrace atomism;

it would have had little application to their conditions of life even if they could have understood it. Even in the more civilized societies, the implied determinism in atomism did not get very far. It is, and always has been, easier to obtain popular acceptance of ideas that propose only slight modifications of established views. This, then, is Plato's position in philosophical history.

Plato revived indeterminism within the higher echelons of Greek thought by extracting from religion the philosophy known as idealism. *Idealism* "is the belief that ultimate reality is *psychical*, or *spiritual*, in its nature, and that the universe is the embodiment of mind or spirit."[13] Plato emphasized the indeterministic, absolutist aspects of atomism and combined them with the geometrical representations that were so useful in Greek culture. His work concentrated on joining the idea and the form so tightly that, for Plato, the idea-form or *ideal* became the only true reality. Plato did not deny the existence of less-than-perfect objects in everyday life; he simply claimed that such imperfections were only apparent and that the idea-form was its true essence.

Today we see the idea-form as deterministic in a way that Plato never intended. In science, as in other walks of life, we find it necessary to represent collections of things as generalized "objects" or ideal forms. We use ideal end members to describe nature as I did in depicting the philosophical continuum. Modern determinists, though, assume that these idea-forms cannot exist in reality, carefully avoiding Plato's major mistake, for which he always will be known as an indeterministic philosopher.

Double-talk Becomes Explicit: Descartes and Classical Dualism (Seventeenth Century)

We now skip more than two millennia to a period in which society once again required extensive philosophical development. Of course, there were numerous cycles in the intervening period. After Plato, Lucretius led a resurgence of atomism in Rome, and the Middle Ages in general were a wholesale regress to indeterminism. Then, in the seventeenth century, an Englishman, Thomas Hobbes, presented the first of the modern determinisms that accompanied industrial and scientific expansion. The need for determinism in science collided with the traditional indeterminism in religion. The battle between them raged at close quarters with the first great experimental scientist, Galileo, being one of its renowned victims.

A truce was called for and Rene Descartes, a brilliant mathematician and the founder of algebra, proposed the compromise. His suggestion was the first explicit formulation of philosophical dualism. *Dualism* is the view that the universe consists of or is explicable as two fundamental entities, such as mind and matter. In Descartes, we find a clear recognition of the usefulness of determinism in science and the need to accommodate the indeterminism in the greater society. The compromise had to be sophisticated and ambiguous enough that the inevitable hints of special pleading would be obscure.

Descartes's two irreducible elements consisted of the material realm of "extension" and the immaterial realm of "thought." In keeping with the vast generalizations then being inspired by early developments in mechanics, Descartes considered everything, even human bodies, to be governed by completely deterministic laws. But the human being, unlike other animals, possessed consciousness and an immortal soul which was not strictly dependent on the body for its existence.

The compromise allowed science to continue developing at a rapid pace free from interference by the Church. Descartes's accord has been enduring. Versions of it abound in modern, specialized science as well as in the popular mind. The modern Myth of Exceptionalism (to be discussed at the end of the book) springs from Cartesian dualism.

Determinism Reacts: Spinoza and Pantheism

With Baruch Spinoza we return to a period in which determinism again could be expressed explicitly—in our story, one full turn of the determinism-indeterminism spiral. By this time there was considerable progress. The changing conditions in society caused philosophers to focus on new subject matter, and by highlighting new issues, even indeterministic philosophers inadvertently contributed to the advancement of determinism. Attempts at formulating an indeterministic position, particularly a dualism, in which the contradictions appear side by side, tend to be especially effective in stimulating clearer heads to rise to the challenge. Such was the case with Spinoza, who, according to Mead,[14] was the greatest of the pre-contemporary determinists. Spinoza saw Descartes's dualism as an intellectual travesty and said so, getting excommunicated from the Church in the process.

As a representative of determinism Spinoza sounds remarkably up to date: "Men are born ignorant of the causes of things and yet have a desire of which they are conscious to seek for their own utility … Men believe themselves to be free simply because they are conscious of their own action, knowing nothing of the causes by which they are determined."[15]

Once again, the world had been made whole in the eyes of those who wished to see it that way. With Spinoza's help, social scientists, in particular, could scale Descartes's dualistic barricade. Once again, no part of the universe was off limits to human curiosity. A part of Spinoza remained indeterministic, however, advancing the theory of pantheism, the view that god and the universe are identical. This particular compromise with theism has its own problems. At least, it appeared of no particular benefit in the work of an important follower: Albert Einstein.

Indeterminism Reaches a Dead End: Berkeley and Subjective Idealism (Eighteenth Century)

The determinism espoused by Spinoza and by Hobbes before him was particularly strong, requiring an equally strong answer from the indeterminists. Whereas others ignored the rise of determinism or simply reviled the people who advocated it, Bishop Berkeley pursued the logic of indeterminism to the bitter end. In *subjective idealism*, Berkeley brought together the indeterministic elements of philosophy in a sophisticated and logically consistent statement of the proposition that reality is internally derived, and concluded that matter does not exist independent of the observer. In other words, if there were no one to observe it, the universe would not exist. This is the opposite of the scientific assumption of *materialism* to be discussed later. Berkeley was well aware of the relationship between motives and assumptions and had guessed correctly that there would be a strong reaction to the assumptions inspired by science: "It is worthwhile to reflect on the motives which induced men to suppose the existence of material substance; so that having observed the gradual ceasing and expiration of those motives, we may withdraw the assent that was grounded on them."[16]

Because it is so extreme, it is hard to find deterministic elements in Berkeley's view, but in carrying out his mission, he clearly demonstrated that opposing assumptions exist. And with his emphasis on sense impressions, he drew attention to the connection between subject and object. These are features of the world that many indeterminists would just as soon ignore. As I will demonstrate later, subjective idealism is far from dead; there are significant remnants of it in modern physics.

Dualism Finds Spirited Matter: Hegel and Objective Idealism (Nineteenth Century)

This time, indeterminism had gone too far. Even dualism would be an obvious improvement over the solipsism engendered by Berkeley. Georg Hegel prepared the compromise, proposing objective idealism, which, instead of hypothesizing a mind or spirit for each person, claimed that only one mind or spirit existed in the entire universe. Matter, however, was not to be denied; it was simply another realm, though secondary, in that it was merely the vehicle through which the mind or spirit worked. Like Descartes's dualism, this one had its special advantages. Since the hypothetical spirit worked in all things, Hegel's attention turned toward matter in a way that was, at base, deterministic. For Hegel, as for the scientist, nature was orderly; causes produced effects according to rigid laws. In addition, there was a purposive trend to the motions of matter, with evolution bringing forth a greater and greater realization of spirit through humanity. Indeterminists, too, could be satisfied that, although matter might be controlled by other matter in minute detail, the concept of spirit-mind held hope for true freedom. After all, Hegel's dialectical method was in relative accord with Newton's descriptions of the motions of matter in mechanics. Why couldn't it be used to view the "relationship" between matter and spirit?

Determinism Divides the World: Marx and Dialectical Materialism

With Karl Marx, we pass through the most recent and most politically powerful shift to determinism the world has ever known. Marx began in philosophy as a Hegelian dualist, but under the influence of French materialism, soon became critical of Hegel's mysticism. Marx was profoundly affected by the great human suffering that was taking place at the behest of the Industrial Revolution. By developing the deterministic elements in Hegel, Marx set about analyzing the material realities of everyday life. For Marx, the most important dialectical conflict was between labor and capital, not matter and spirit. Along with Frederick Engels, Marx was the founder of historical materialism and economic determinism, which were components of the philosophy and method that later became known as *dialectical materialism*, which, according to one definition, is "the theory of reality affirming continuous transformation of matter and dynamic interconnectedness of things and concepts, and implying social transformation through socialism toward a classless society."[17]

If the indeterminists among the favored classes did not have enough reasons for rejecting determinism, now they had one more: the specter of a classless society.

Marx and Engels wrote no single volume that gave a comprehensive treatment of their philosophy; it is scattered throughout their works.[18] Their concentration on economics and history left us with an incomplete system focused in the humanities. Near the end of his life, Engels tried to remedy this by applying the philosophy to natural systems in his unfinished book *Dialectics of Nature*.[19] In it, Engels professed a general belief in causality[20] and laced it with comments derived from deterministic assumptions. Nevertheless, he took a cue from Hegel in using dialectics both to oppose and to unite chance and necessity in a confusing, self-contradictory analysis,[21] revealing that determinism was to be neither the starting point nor the ending point of dialectical materialism. To this day, the Aristotelian assumption that chance implies acausality remains a fundamental,[22] if unsteady, part of the philosophy.[23]

Indeterministic elements are more common in the young Marx—works written prior to 1845—than in the mature Marx. Similarly, his interpreters divide into two camps: the indeterminists, tending to associate with social democracy, and the determinists, tending to associate with Marxism-Leninism.

Indeterminism Wakes Up with Science: James and Pragmatism

Since Berkeley had worked out the logical consequences of indeterminism, and because few people found the resulting solipsism either useful or believable, new developments in indeterminism simply would require dualistic elements. The world of non-Marxist philosophy developed its indeterministic extreme as far from the influence of dialectical materialism as possible. This turned out to be Harvard University, where William James demonstrated the easy transition from American scientist to indeterministic philosopher. The immediate stimulus for James was Thomas Huxley's special brand of dualism called agnosticism, which had been a response to the atheism implied in European scientific developments of the nineteenth century, particularly those in geology and biology.

James is best known for pragmatism, a philosophy characteristic of deeply religious countries undergoing rapid scientific and technological development within the capitalist world. According to Mead, *pragmatism* is built around these major points:

1. The meanings of all conceptions are to be found in their practical bearings.
2. The function of thought is to serve as an instrument of adaptation and as a guide to action.
3. The primary test of truth is the practical consequences of our belief.[24]

Well and good, but James also saw fit to link theism, free will, and "absolute chance" in a rigorous attack on determinism.[25] Pragmatism is an advance on previous indeterminisms because it rejects the absolutism found in Plato, Berkeley, Hegel, and others. Also, in pointing out utility as the criterion for philosophy, pragmatism allows for future changes in doctrine—a flexibility not especially characteristic of earlier indeterministic philosophies.

Dualism Finds Atheism: Sartre and Existentialism (Twentieth Century)

If there was to be a renaissance of determinism in the modern era, it was inevitable that philosophy would first pass through dualism. It also was not surprising that this development should occur in France, an advanced country in which deterministic and indeterministic philosophy were in intense and prolonged conflict. A major result of this confrontation has been Jean Paul Sartre's *atheistic existentialism*, in which individuals are seen to create their own existence through their own free choice of action and interest.[26] Coming from the humanistic tradition and developing his ideas in consort with systems philosophy, Sartre considered the individual to be of primary importance and possessed of an especially overbearing free will. As with James, Sartre's idea of free will was linked with absolute chance, which was at the same time finding great favor in physics.

Existentialism rejects the claim of purposive or conscious design of the universe, an idea it sees as intimately tied to theism and idealism. Accordingly, life is an aimless wandering in which the individual encounters one accident after another and must contrive temporary commitments in order not to succumb to suicidal pessimism. The indeterminism in Sartre, like that in Descartes, poses an obstacle for psychology, for under both systems, humans, especially their thought processes, generally are not considered legitimate concerns of scientific research.

Nevertheless, the deterministic elements in existentialism are paramount. Its atheism constitutes an advance on other dualisms, and it generally does not shirk from criticizing value systems founded on absolute, indeterministic assumptions. On the other hand, the subjective approach that appears central to existentialism presents a major difficulty for theoretical science, as will become clear later, especially in the discussions of neovitalism and exceptionalism.

Over the long haul, the philosophical continuum proceeds toward an ever-more deterministic position. We see it here in formal philosophy, and careful observation uncovers it in the evolution of all cultures. Moreover, it is evident in individual intellectual growth. Each of us moves along a personal determinism-indeterminism continuum. We start life as subjective idealists, with blankets over our heads, and move toward a more deterministic position as our intellectual horizons expand. It is a commonplace that the immature and inexperienced tend to be "idealistic" and that the mature and experienced tend to be "realistic." Of course, individual progress toward the deterministic end of the continuum is not without an occasional regress. There is a spiral for each of us just as there is for humanity as a whole.

In the remainder of the book, and still in the determinism-indeterminism framework, I will take another look at philosophy by adding an extra dimension to the analysis. Among the philosophical approaches that purport to be overtly scientific, two of them—classical mechanism and systems philosophy—are dialectically opposed. Fundamentally, their dispute is over the proper answer to the ancient question, "Is it the outside or the inside of things that is the most important?" And as implied, a third, dialectical materialism, comes closest to handling the contradictions between the two, but like the others, it has no adequate answer to Aristotle's concept of absolute chance.

The Call to Determinism

One could argue that, even if we assumed existentialistic dualism, pragmatism, or dialectical materialism to be the current state of philosophy, a regress to indeterminism would be just as likely as a renaissance of determinism. That might be possible except for an important factor: the association between determinism and survival. Indeterministic philosophers can afford to speak of effects without causes, but the rest of us must deal with an external world that stubbornly refuses to honor that notion. Real starvation and real bullets cause real deaths. Most people concede that humanity is in for a difficult period as globalization proceeds apace. The unique, relative isolation that modern physics and science have enjoyed within the industrialized countries can no longer be assured. The gap between the rich nations and the poor nations has grown so wide that the struggle between them is sure to intensify. It is virtually impossible for the indeterministic elements of science and philosophy to remain sheltered from that clash. The survival of philosophies, their assumptions, as well as their proponents will not be decided by "accident," as current philosophy and modern physics seem to contend, but by cause and effect. Those individuals and groups who learn this lesson well will be among the survivors.

Part Two

The Assumptions

Chapter 3

The Ten Assumptions of Science

We cannot prove anything except from something that is already admitted.[27]

In my recent book, *The Ten Assumptions of Science*,[28] I presented the logical foundation for the scientific worldview in detail. In particular, I explained why assumptions were necessary for doing science and philosophy: because the universe is infinite, there is no *a priori* starting point from which to begin thinking. This matter of assumptions is a highly contentious part of the determinism-indeterminism debate. Most Western scientists, having been taught to be empiricists, obediently maintain that assumptions are unneeded and undesirable. But as shown by R. G. Collingwood,[29] scientists nevertheless base their work on unconscious presuppositions. These are not drawn forth as explicit assumptions unless the resulting scientific conclusions become unpleasant.

Following Collingwood's guidelines, the ten assumptions were carefully prepared as a consupponible constellation. That is, belief in any one of these assumptions poses minimal contradiction with belief in all the others. They met one other critical requirement: to be considered fundamental, each deterministic assumption had to have an indeterministic opposite. Thus, for example, the universe is either infinite or finite. It is impossible to travel to the end of the universe to determine which assumption is correct. These assumptions go beyond Newton because his description of the fundamental laws of the universe was based on mathematical equations, which necessarily must be of finite length. They go beyond Einstein because his objectification of time likewise requires a belief in finity.

In this chapter I present an adaptation of the ten assumptions. Further details on the necessity for assumptions and the manner of developing them are given in the introduction to the earlier book. A single italicized word will refer to each of these specific assumptions and my interpretations of them. The rejected and opposing indeterministic assumptions will appear in bold italics (Table 3-1).

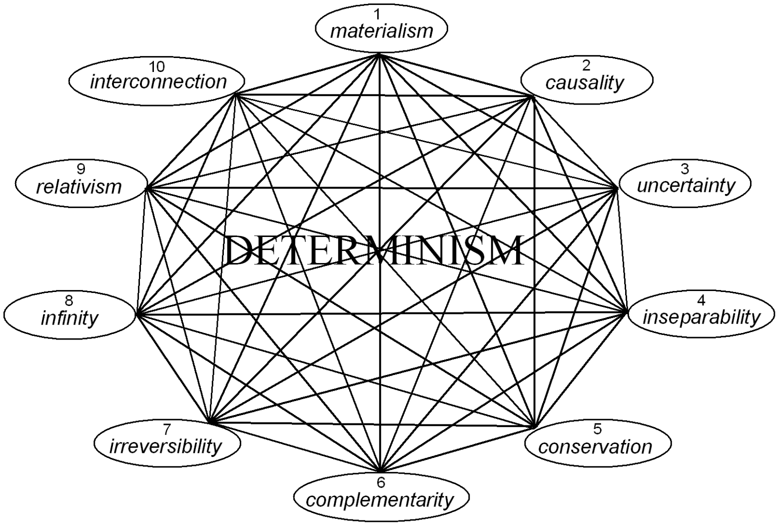
Table 3-1. The Ten Assumptions of Science and their opposites.

No.	Deterministic Assumption	Indeterministic Assumption
1	*materialism*	***immaterialism***
2	*causality*	***acausality***
3	*uncertainty*	***certainty***
4	*inseparability*	***separability***
5	*conservation*	***creation***
6	*complementarity*	***noncomplementarity***
7	*irreversibility*	***reversibility***
8	*infinity*	***finity***
9	*relativism*	***absolutism***
10	*interconnection*	***disconnection***

In brief, the First Assumption of Science, *materialism*, posits an external world of material objects that exists after the observer does not. The Second, *causality*, posits an essential connection between material objects so that the motion of one influences the motion of another. The Third, *uncertainty*, states that a complete knowledge of an object, cause, or effect is impossible, although an improvement in knowledge is always possible.

The laws of thermodynamics have achieved the status of basic assumptions recognized in all scientific disciplines. The Fourth Assumption of Science, *inseparability*, is a liberally expanded development of the Third Law of Thermodynamics which is, according to this deterministic interpretation, a modern configuration of Hegel's dictum that there can be no motion without matter and no matter without motion. The Fifth, *conservation*, the First Law of Thermodynamics, states that matter and the motion of matter neither can be created nor destroyed. The Sixth, *complementarity*, asserts the relationship between the Second Law of Thermodynamics and its neomechanical complement which, together, assume that all objects are subject to divergence from and convergence on other objects in the universe. The Seventh, *irreversibility*, also stems from the deterministic interpretation of the Second Law of Thermodynamics and its complement, which asserts that the interactions of all objects are unique.

The eighth assumption is perhaps the most mind-boggling of all assumptions: *infinity*, the proposition that the universe is infinite in both the microscopic and the macroscopic directions. The Ninth, *relativism*, assumes that no two things or events are completely similar or completely dissimilar. The Tenth, *interconnection*, assumes that all things in the universe are interconnected and interrelated. This last assumption is illustrated in the assumptions themselves, for they are all interdependent and consupponible to a large degree. An adequate understanding of any one of them requires an understanding of all the others. This is not strictly true for the indeterministic assumptions (Fig. 3-1).



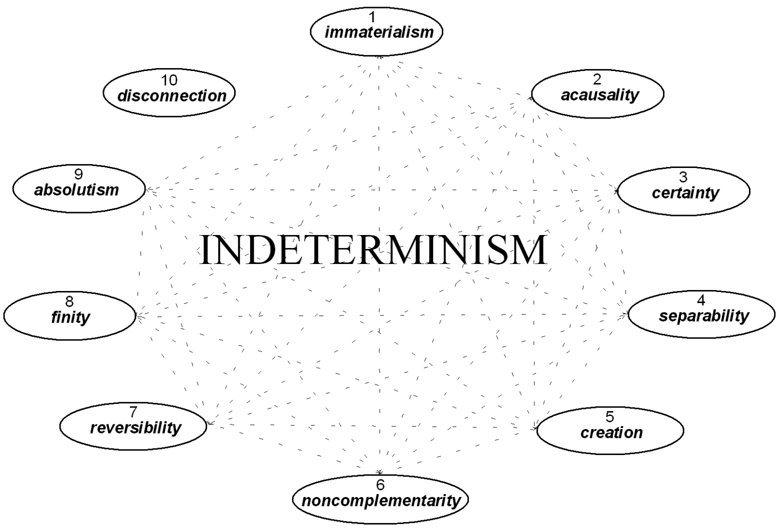


Fig. 3-1. The Ten Assumptions of Science and the opposing indeterministic constellation.[30] Solid lines indicate the degree of consupponibility, which is not required for a "constellation" containing ***disconnection***. Although most scientists tend to use mostly deterministic assumptions, modern physicists and astronomers tend to use many of the indeterministic assumptions.

The First Assumption of Science: Materialism

The external world exists after the observer does not.

At first thought, *materialism* appears obvious. How could anyone believe that the external world does *not* exist? How could anyone *not* be a materialist? Even the etymology of the words "*ex*ternal" and "*ex*ists" begs a practical, matter-of-fact acceptance of this, the First Assumption of Science. But as with all assumptions in an infinite universe, experience can provide only *support* for *materialism*, it cannot *prove* it beyond a shred of doubt.

We are born consisting of and surrounded by the "stuff" we call matter. We may have no particular bias concerning *materialism*, but any interaction with the external world unavoidably breeds adherence. Children at first assume that they can make the world go away by covering their heads with a blanket. After additional experimentation, most children discard the view that the existence of the world depends solely on them. We are encouraged to "get real" or "to get out more" whenever our views of the external world are "out of touch." The upshot is that education unavoidably promulgates belief in *materialism*.

As there always will be less educated beings, there always will be those who mistakenly believe in ***immaterialism,*** the assumption that reality is internally derived. Thus, in the heat of philosophical conflict it often becomes necessary to state the obvious. Even Albert Einstein was moved to remind himself and others that "The belief in an external world independent of the perceiving subject is the basis of all natural science."[31]

Through the ages, not a few indeterministic philosophers have tried to prove just the opposite; the latter point of view reached its zenith in the philosophy known as subjective idealism. In typical fashion, its major proponent, Bishop Berkeley, was led to write:

> It is indeed an opinion strangely prevailing amongst men, that houses, mountains, rivers and in a word all sensible objects, have an existence … distinct from their being perceived by the understanding. But this principle involves a manifest contradiction. For what are the aforementioned objects but the things we perceive by sense? … Their esse' is percipi; nor is it possible they should have any existence out of the minds which perceive them.[32]

The Berkeleian past echoes in the sentiments of those who ask, "If a tree falls in the forest and there is no one there to hear it, does it still make a sound?" The naïve realist,[33] as well as most practicing scientists, quickly say yes it does, but the idealist, preferring the subjective definition of sound, is not so sure.

One might think that scientists, at any rate, would be in unanimous agreement that only *materialism* bears the test of experience. This is not the case, for ***immaterialism*** has always had numerous backers within the scientific community.

A common indeterministic interpretation is an extension of the naïve realism that produced *materialism* in the first place. Naïve realists tend to believe that the objects of the external world are self evident and directly perceived, as they exist in reality. Their picture of the external world comes in loud and clear, and there are no transmission problems. In asserting the physical independence between the observer and the object observed, they often tend to deny the material interconnections necessary for perception.

We observe the external world, however, only through our five senses—far from perfect instruments. The naïve realist is likely to be enamored with sensory perception in the visible part of the spectrum, forgetting, or being unaware, that this is only a tiny fraction of the radiation emitted from material objects. We cannot see X-ray or infrared radiation, but these also are interactions occurring in the material world. The "reality" one would derive from vision in these parts of the electromagnetic spectrum would be considerably different from the one we know. Being ourselves finite, material portions of an infinitely rich universe, we are limited. We see the world as it appears; it is impossible to see it as it really is.

The definition of *materialism* that I prefer attempts to avoid the possibility of an indeterministic epistemological interpretation by emphasizing the metaphysical nature of the assumption. This definition certainly does not admit of a complete, ultimately personal test. There will never be a way for me to know for certain that the universe exists after I do not. Nevertheless the indirect and incomplete evidence that is available to me is sufficient to lead me to the "leap of faith" that is the primary basis for all science. Personally, I do not consider this "leap" to be of any consequence, but I see no reason to deny that it exists.

Matter

According to *materialism*, the sensory impressions we receive from the external world result from the motions of matter. "Matter" is defined as an abstraction for the world of physical objects. It is the name we give to the class that includes all things. The category "matter" is like the category "fruit." One cannot eat a "fruit"; one can only eat a specific kind of fruit such as an apple or an orange. Thus, in the strictest sense, matter, like fruit, does not exist; only specific, concrete examples of matter can exist. Matter is definitely not what it was once thought to be: a sort of filling or substance within the indivisible atoms of which the external world is composed.

In the modern view, matter consists of specific objects within specific objects *ad infinitum*. Even though conceptions of the nature of matter vary considerably, those emphasizing its importance usually assume it continues to exist after the observer is gone.

This objective view stresses the importance of the external world of matter, and thus is philosophically opposed to subjective idealism. And because it emphasizes the importance of matter, this philosophy is called materialism. Materialism is "a theory that physical matter is the only or fundamental reality and that all being and processes and phenomena can be explained as manifestations or results of matter."[34] A materialist might be heard to say "You and I can *imagine* spirits, ghosts, and all sorts of things, but when I hit this wall with my hand, it's *real!*" Science is, by definition, materialistic in this way, demanding that its theories and explanations confront the external world.

Without these confrontations, without observations and experiments, and without a firm belief in *materialism*, science may slip into idealism, the belief in ***immaterialism***, its opposite. As we have seen, this is what happens from time to time in disciplines in which the confrontation with the external world is especially difficult to achieve. Scientific or intellectual work that is done in relative isolation from the outside world invariably suffers from a degree of subjective idealism. It is only when that relative isolation is broken that the merits of *materialism* are reaffirmed. Eventually the theoretician is put back on course by the *ex*perimentalist.

Whether or not we admit it, we are all materialists. We derive from the external world the "faith," "assumption," or "knowledge" that the external world exists. We could not walk another step if we did not. But the characteristics of matter are not everywhere the same. We may imagine that the ground ahead will support our weight, or we may imagine that it will not. Determinists simply claim that the way to find out is to interact with that portion of the external world. As Max Planck, the famous physicist, put it, "The chief quality to be looked for in the physicist's world-picture must be the closest possible accord between the real world and the world of sensory experience."[35]

Confirmation

Anyone who has suffered impaired sensation or has experienced hallucinations knows how difficult it is to distinguish the external world from the internal world. Sometimes, to make this distinction, we need a little help from our friends. We assume that matter has certain characteristics that others can sense in ways similar to our own. To improve our confidence in our sensory perceptions, we seek confirmation of our initial conclusions. We do this either by repeating our observations and experiments, or by comparing them with those of others.

This desire for confirmation makes science a group effort. Even the most independent scientists rely on thousand of volumes of scientific reports and accumulated data. The words of departed scientists echo from the past, challenging those who follow to confirm or to reject their interpretations. All scientists must make their work available for confirmation or give up pretensions of advancing knowledge. Those who see some feature of the world in a special way must be able to teach others how to see it too. By interacting with others, we discover our failures in perception and adjust our viewpoint to be more in tune with reality. The collective "faith" of scientists differs from the collective "faith" of religious believers only in so far as it reflects a more intensive and extensive experience with the external world.

Confirmation is sought in all walks of life. People avidly seek testimony from others who support their opinions. When this support is not forthcoming, people become disappointed, censorious—even violent. If contradiction brings war, confirmation brings peace. Ironically, those who feel contradicted by the assumption of *materialism* often behave in ways that betray their need for confirmation and their doubts that they can exist in the world without interacting with it.

Faith and Matter

Except for a few theoreticians in modern physics, most scientists consider *materialism* hardly worthy of debate. Nevertheless, within science, indeterministic interpretations of *materialism* stem from naïve realism or from religious interpretations of "faith." Both conflict with the deterministic viewpoint because, like overt ***immaterialism***, they hypothesize a physical ***disconnection*** between humans and their surroundings that simply does not exist. Over 160 years ago Ludwig Feuerbach[36] showed that faiths of all kinds were derived from the material existence of the people that held them. The gods of warriors were warriors; the gods of shepherds were shepherds. Contrary to the believers in "free will," a faith, whether deemed religious or scientific, does not simply pop into one's head out of nowhere. The validity or truth of a particular faith, assumption, or bit of knowledge cannot be decided merely by imagining that it was caused or uncaused, but by testing it in the external world.

The Second Assumption of Science: Causality

All effects have an infinite number of material causes.

Materialism posits an external world consisting of material objects, but it does not necessarily require one to believe that those objects exist in anything but rigidly fixed positions, each isolated from the other. The concept of causality, on the other hand, assumes that the objects of the external world are in motion relative to each other and that all objects are influenced by the motions of other objects. Without a belief in causality, we could still believe that things exist outside ourselves, and we might observe them, but we could not link their motions; we could make no interpretations or predictions. The motions of objects would appear nonsensical, and life would be a meaningless blur of events. In the opinion of Hans Reichenbach, the famous positivist[37] philosopher of science, "if we did not believe in causality, there would be no science."[38] In science, as in life, we seek meaning by discovering the causes of effects.

But, as we shall see from Reichenbach himself, there are widely varying interpretations of the notions of causality. If causality is the proposition that *all* objects are influenced by the motions of other objects, then ***acausality*** is the absurd proposition that *no* objects are influenced by the motions of other objects. With only a few exceptions associated with the philosophy of modern physics,[39] most indeterminists do not advocate this extreme position. Instead of invoking ***acausality*** as a generalization, they invoke it only in specific instances. To most people, at least a few events seem to have obvious material causes. Nowadays it would be difficult, for instance, to convince educated people that the motion of the leaves waving in the wind was not caused by the influence of moving air molecules instead of riled spirits.

There are three major views of causality: "specific causality," which assumes that some effects have material causes, but that others may not; "finite universal causality," which assumes that all effects have a finite number of material causes; and "infinite universal causality," which assumes that all effects have an infinite number of material causes. In this section and the next I show that only infinite universal causality should be considered the modern, deterministic interpretation of *causality*. The others, however, must be understood as well.

Specific Causality

As numerous devout scientists attest, one does not require a belief in a generalized version of causality to do specialized work. Moreover, in the strictest sense one doesn't even need to assume a cause exists to look for one; "We can leave this question open, like the question of what is the cause. Only if we knew that there is no cause would it be unreasonable to seek for a particular cause."[40]

In dealing with specific problems, the indeterminist believes rightly that general or universal causality "is certainly not the logical presupposition of the particular causal law under investigation."[41] This pragmatic position is all that is required to begin scientific investigations. You don't need a degree in scientific philosophy to do science.

For the indeterminist, the major advantage of specific causality is its consupponibility or agreement with its opposite: specific ***acausality***. Some objects may appear to be influenced by the motion of other objects, but still other objects appear to be uninfluenced by the motion of other objects. By maintaining that the external world is only partly dynamic, even materialists could avoid being strict determinists.

Unfortunately, the association of causality with motion and ***acausality*** with the lack of motion has proven to be an errant mistress for the indeterminist. Ever since Einstein disposed of the possibility of a preferred frame of reference, thus validating the view introduced by Heraclitus that "everything is in flux," the notion of absolute rest has taken a beating. If no thing is perfectly static, then no event is acausal.

If specific ***acausality*** and indeterminism were to be rescued from the ruins created by a dynamic external world, the association between motion and causality had to be soft-pedaled. Early in the history of philosophy, Aristotle developed the possibilities for a lasting divorce. As Aristotle saw it, events come about in three ways: 1) by external compulsion, 2) by internal compulsion, or 3) without definite causes but by absolute chance.[42] C. S. Peirce considered the doctrine of absolute chance to be the "utmost essence of Aristotelianism."[43] Indeed, it deserves to be called the essence of twentieth century philosophy and science as well. Wherever the doctrine of absolute chance is invoked, the association of causality with motion is severed cleanly. Like his descendents, Aristotle did not deny causality altogether; that would have been intellectual suicide. Instead, he assumed causality for specific instances and denied it for others. If one were to make an assumption of universal causality, the contradiction with its opposite, universal ***acausality***, would become obvious and would force a choice between determinism and indeterminism. The doctrine of absolute chance neatly avoided that.

The disjunction between causality and motion allowed Aristotle and his followers to return to the *argumentum ad ignorantiam*; because none can be found, therefore the cause for a particular effect does not exist. This dogma naturally led to the association of causality with law and absolute chance with lawlessness. Whatever could be described by means of causal laws was causal; whatever could not was not. This subjective view made specific causality logically consistent with ***acausality***. Even as a sometime believer in causality, Reichenbach, in particular, was moved to resurrect Berkeley's ghost; "The relations controlling unobserved objects violate the postulates of causality."[44]

It is often difficult to know when a specific law or assumption is applicable. It is appropriate, however, that this interpretation of causality chooses as its limitation the boundary between the observed and the unobserved. Thus, according to Reichenbach, "Causality is an empirical law and holds only for macroscopic objects, whereas it breaks down in the atomic domain."[45] But, as it turns out, the events of the atomic domain are not completely unobservable either. Some information can be obtained, although it is indirect and generally has a great deal of statistical variation. The nature of the probability distributions drawn from such data will be discussed in the next section. For now, it may suffice to note the similarity between Aristotle's view of absolute chance and Reichenbach's twentieth century view of the laws of probability: "The idea of strict causality is to be abandoned and the laws of probability take over the place once occupied by the law of causality."[46]

There are varying interpretations of what is being said here, but, as I will argue in more detail later, there is no fundamental difference between the notion of absolute chance and this all too common view of the laws of probability. Their veiled philosophical purpose is to avoid an assumption of universal causality.

Despite its great success in specialized science, we cannot use specific causality as the basis for scientific philosophy. The failure of specific causality is demonstrated whenever one attempts to use it for making general philosophical and scientific statements. This is perhaps the most flagrant abuse of specific causality, because even a vague familiarity with logic should remind us that a deduction cannot be more general than its premise.

Finite Universal Causality

In spite of Aristotle's great influence on twentieth century science, the most broadly experienced scientists still insisted on employing a universal form of belief in causality. On occasion, such sentiments are made explicit even in reports on specialized topics. For example, in a paper discussing the origin of life, Linus Pauling, the twice-named Nobel laureate, and his coauthor, Emile Zuckerkandl, reminded their readers that "Causality, determinism—this rule is considered to apply intrinsically, to the relation between *all* phenomena, until proof to the contrary is forthcoming."[47]

In one form or another, the extreme, generalized view of causality persists in spite of the indeterministic borrowings from ancient Greece. Even staunch indeterminists must admit, "Science has advanced in the past precisely because, when things happened whose causes were unknown, it was assumed that they had causes nevertheless."[48]

The evolution of the belief in the applicability of the universal generalization was a tremendous advance in thinking—one that is now more easily accepted than 2,400 years ago when Democritus first introduced it. It took living organisms billions of years to transcend the myopia of specific causality. Today, we can do it in a fraction of a lifetime. Generalists and interdisciplinary scientists often develop a belief in universal causality after first using specific causality in narrow disciplines. Subsequently, and often subconsciously, they find that a new, specific assumption for each investigation is unnecessary. Unless they are continually admonished, they naturally slip into the carefree habit of assuming universal causality.

But there are two major forms of universal causality: finite universal causality and infinite universal causality. Let us review finite universal causality first, since it appeared first and remains the most common conception of universal causality.

Perhaps the best explanation of finite universal causality was given by Pierre Simon Laplace, the philosopher-scientist who, independently of Kant, advanced the nebular hypothesis of the origin of the solar system. Laplace illustrated his view of determinism by hypothesizing a super intelligent being that has come to be known as Laplace's Demon:

> We ought to regard the present state of the universe as the effect of its antecedent state and as the cause of the state that is to follow. An intelligence, who for a given instant should be acquainted with all the forces by which nature is animated, and with the several positions of the beings composing it, if his intellect were vast enough to submit these data to analysis, would include in one and the same formula the movement of the largest bodies in the universe and those of the lightest atom. Nothing would be uncertain for him, the future as well as the past would be present to his eyes.[49]

As did Einstein, a few old-fashioned "determinists" still hold to this view, although it has suffered at the hands of determinists and indeterminists alike. We now recognize that Laplacian determinism is invalid because it contradicts a major Assumption of Science, *infinity*, to which Einstein, of course, also did not subscribe. In his fanciful illustration, Laplace was implying that the cause of a particular effect could be determined with absolutely perfect precision, that the motion of a particular body is determined solely by a finite number of the motions of other bodies.

But any concept of knowledge also requires the concept of subject and object. In 1927, Werner Heisenberg presented the Uncertainty Principle, which demonstrated that the knowledge required of some objects, at least, could not be obtained without interfering with those objects. The interference produces changes in motion that, in turn, cannot be evaluated without additional interference with the object. This leads to an infinite progression in which, theoretically, Laplace's Demon would require infinite time to determine the position and momentum of a single object. The demon would be so busy in this effort that it would be forced to ignore the rest of the universe. Unobtrusively, the assumption of *infinity*, the materialist theory of knowledge, and the Heisenberg Uncertainty Principle presided over the death of Laplacian determinism and the theory of finite universal causality.

Infinite Universal Causality (Causality)

After Heisenberg's discovery, the hopes for a consistent determinism grew dim. But thirty years later, David Bohm, the philosopher-physicist, showed that still another view of universal causality was possible. In his masterful classic, *Causality and Chance in Modern Physics*,[50] Bohm presented an especially elegant exposition that inspired at least one author to consider him the first to prove "the logical possibility of a deterministic model."[51] Bohm showed that the quantum mechanical laws to which the Heisenberg Uncertainty Principle applies could not be assumed to be inviolate. As for statistical probability in general, Bohm pointed out that future investigations of the atom are likely to uncover causal laws that explain some of this present uncertainty. Even so, the infinity of nature will always require a statistical approach each time we arrive at one of these deeper levels of organization. Although we temporarily may be unable to find a material cause for a particular phenomenon, the cause nevertheless exists.

By using an explicit assumption of infinity, Bohm demonstrated that the "cause" for an "effect" is never established with absolute ***certainty***.[52] We must always accept something less because both the cause and the effect, like the objects they describe, have infinite properties. Nevertheless, some of these properties are more important than others, and by concentrating our attention on the most important, we define a cause for an effect. Like all good pragmatists, we are satisfied with the approximation as long as it is useful to us. At a later date we may find that additional factors are important in predicting the effects of causes, so we will include them in our considerations. In no case, however, should we delude ourselves into thinking we have discovered all of the factors involved, for in principle, they are infinite in number.

Example of *Causality*

As an illustration of the assumption of infinite universal causality *(Causality)* let us consider the position of the Earth in relation to the sun. Newton's law of gravitation states that the gravitational effect between two objects increases with mass and decreases with distance. At a particular moment, this law provides an approximation of the distance between the Earth and the sun. The predicted distance and the actual distance, however, are never identical. This is because the gravitational fields of other astronomical bodies also influence both the Earth and the sun. The moon, for instance, causes a noticeable wobble in the path described by the Earth around the sun. So do other planets, but their effects are only a couple percent of the moon's effect. By including the effects of the gravitational fields of all the planets in addition to that of the moon, we can develop a finite set of equations that will predict the distance between the Earth and the sun with reasonable accuracy. The prediction, however, can never be *perfectly* accurate. There always will be astronomical bodies in addition to the ones we have considered that will contribute gravitational effects upon the Earth. These influences are so slight that we can usually neglect them. In practice, we *must* neglect some of them, because the number of astronomical bodies is infinite, with 100 billion stars in each of 100 billion galaxies estimated to be within the view of our telescopes alone.

The achievements of Newtonian celestial mechanics arose out of such judicious neglect and amounted to the reduction of the infinite complexity of the universe to the simple consideration of just a few bodies. The practical, mathematical necessity of working with a finite number of causes engendered the mistaken belief in finite universal causality and its corollary, the idealistic belief in the possibility of perfect accuracy. Although this approach was, in the main, highly successful, it always had a disconcerting element of failure. Each claim for perfect accuracy was eventually overthrown by more detailed work showing that prediction and reality did not coincide exactly. Closer agreement could be obtained only by expanding the number of causes used to predict a particular effect. *Causality* assumes that, because the universe is macroscopically and microscopically infinite, the number of these causes is in principle infinite. Practical success is achieved in the way the mechanists did it: by reducing the number of causes to those having the most significant impact on the problem at hand. The philosophical distinction between the finite and the infinite versions of causality is thus simply this: *causality* consciously assumes that failure in prediction at some point is inevitable, and always requires a search for additional or more appropriate material causes for its correction.

The analysis so far presented in this example is enough to establish that a phenomenon as "simple" as the distance between the Earth and the sun is affected by the gravitational effects of a theoretically infinite number of astronomical bodies, all of which contribute to the whole, but most of which contribute very little. In addition to this static analysis we can superimpose the fact that all of those astronomical bodies are in motion relative to each other. According to *relativism*, neither the distance between any two bodies nor the mass of either of them is exactly the same at any two moments. By the time we have determined the distances and masses of whatever bodies we are going to use in predicting the distance between the Earth and the sun, the actual values will have changed and so will the actual distance between the Earth and the sun. As a result, no two trips of the Earth around the sun describe exactly the same path or have exactly the same duration.

The overconfidence sometimes engendered by Laplacian determinism, Newtonian mechanism, and their reductionist approach is unwarranted. We can never give a *complete* description or perfectly accurate prediction of any phenomenon because, as we assume under *infinity*, the number of objects to be considered is infinite and each of them is in motion relative to each other and all other bodies in the universe. In practice we may discover a finite number of causes that will enable us to describe and predict with great accuracy and precision, but this should not delude us into believing that the number of causes for a particular effect is finite.

Causality, Motion, and Objectivity

The assumption of infinite universal causality, hereafter referred to as the assumption of *causality*, reunites the concept of causality with the concept of motion. *Causality* is dynamic and objective, not static and subjective. *Materialism* posits an external world of matter, while *causality* posits the dynamic interaction between its parts. Neither its unending complexity nor its unending motion allows us to give a complete causal statement of the motions of even one object relative to all other objects. Matter in motion simply will not sit still for it. Nevertheless, we are able to compile partial, finite statements that we call causal laws and that we find relatively valid for specific instances. An auxiliary belief in uncaused motion can be only a hindrance in this effort.

The Third Assumption of Science: Uncertainty

> It is impossible to know everything about anything, but it is always possible to know more about anything.

According to Pliny the Elder, nothing is certain but uncertainty. Individuals, their philosophies, and their scientific endeavors suffer whenever they cannot handle uncertainty. To be uncertain is one of the most uncomfortable of feelings. Life seems to be a never-ending search for ***certainty***, punctuated by premature announcements that it has been found at last. For millennia, people have looked toward philosophy for the comfort of absolute ***certainty***. The Third Assumption of Science, however, states that they will find only *uncertainty* instead.

While *causality* is a statement about the interactions between objects, *uncertainty* is a statement about what may be discovered about those interactions. For us, the relationship between subject and object is as important as the relationship between objects. To understand *causality*, we must also understand *uncertainty*. To fail to do this is to remain a captive of twentieth century philosophies, best characterized by their enslavement to Aristotelianism. The philosophical choice that we must make is clear: either causality is objective and uncertainty is subjective, or causality is subjective and uncertainty is objective. The historical roots of the way in which scientists make this choice lie within the longstanding search for ***certainty***.

The Search for Certainty

In many ways the search for **certainty** and the search for knowledge are the same, but there are two ways of viewing that search. Indeterminists traditionally have approached the quest with the idea that absolute **certainty** or absolute knowledge actually could be found. Determinists, associated with the rise of scientific philosophy, have given up the search for the absolute and have accepted a relative instead. We no longer seek perfect accuracy and omniscience, only better accuracy and more knowledge. With the advent of the Heisenberg Uncertainty Principle, philosophers and scientists were forced to take a new look at the causality-uncertainty relationship.

When Heisenberg[53] demonstrated that it was impossible to know *both* the momentum *and* the position of a particle at the same time, he hit a sore spot, especially with the Laplacian "determinists." Essentially, he was telling them that, at least in the world of subatomic particles, science was "limited" and aspects of it were uncertain. If one could not be certain of both the momentum and the position of a particle through time, then one could not be absolutely certain of the relation between cause and effect either. Bertrand Russell, the philosopher-mathematician, captured the disillusionment of that period: "The hope of finding perfection and finality and certainty has been lost."[54] Science was forced to admit that *causality* and *uncertainty* were indubitably linked and would have to be *assumed*; there could be no absolute ***certainty***. One could never know everything about anything.

The search for absolute ***certainty*** nevertheless continued. For many, the Heisenberg Uncertainty Principle took on its own kind of ***certainty***. Mystical physicists spoke of it as an opportunity to "dethrone the law of causation."[55]

Many were sure that uncertainty meant there was a "loose jointedness" that destroyed the argument for absolutely strict causation. Russell declared, "The reason why physics has ceased to look for causes is that, in fact, there are no such things."[56] For the religiously indoctrinated, the rationale for indeterminism and its implications for the doctrine of free will brightened.

Determinism: Uncertainty ***is Subjective***

In the Newtonian view expressed by Hermann von Helmholtz, it was "possible to deduce all phenomena from their causes in a logically strict and uniquely determined manner."[57] The search for **certainty** led scientists of the nineteenth century to equate the orderly motions of the external world with the orderly motions of the internal world. Natural law and humanly devised law were thought to be identical.

With Newton, Laplace, and Helmholtz, "determinism" had lapsed into indeterminism; it demanded perfection where perfection was not possible. There may be causes for all events, but it was pure idealism to believe that anyone could know all the causes for even one event. If, as Bohm emphasized, causality involved *infinity*, then the old view of determinism as both objective and subjective had to be discarded.

In deciding between these alternatives, it is instructive to consider the etymology of the word *determinism*. Like the word *law*, it originally described a uniquely human activity. But with the growing belief in *materialism*, both *determinism* and *law* began to take on an objective meaning as well. The objects of the external world were said to "determine" each other independent of a perceiving subject. In the Newtonian view, the motion of one body was "deterred" by that of another. Although there always have been some who saw natural law in a teleological sense, there were others who saw it in a strictly objective sense. Whatever those objects did to each other occurred because there were no other possibilities under the conditions, and not because the objects were following a predetermined script.

Einstein, Planck, and De Broglie remained stoutly opposed to the growing tendency of physicists to interpret the Heisenberg Uncertainty Principle as a sign of ***acausality*** in nature. Einstein, in particular, was vociferous in mounting this opposition from the point of view of traditional, Laplacian determinism. The argument failed because the stronger the case was made for finite universal causality, the greater was the tendency to associate determinism with finite, humanly devised laws. If the temporarily unknown portions of the external world eventually had yielded completely to this mathematically based treatment, then the laws of the scientist and the laws of nature would have coincided perfectly, as Einstein had hoped. Nature, however, refused to cooperate. Being infinite in number, and always in motion relative to each other, the various parts of the external world produced phenomena and natural laws faster than anyone could describe them. In the last analysis, causality could not be proven to be both objective and subjective.

In forcing a choice between the objective and the subjective views, the Heisenberg Uncertainty Principle unintentionally laid the groundwork for a new form of determinism. As David Bohm put it:

> None of the really well-founded conclusions that can be obtained with the aid of the assumption of a finite number of qualities in nature can possibly be lost if we assume instead that the number of such qualities is infinite, and at the same time recognize the role of contexts, conditions, and degrees of approximation. All that we can lose is the illusion that we have good grounds for supposing that in principle we can, or eventually will be able, to predict everything that exists in the universe in every context and under all possible conditions.[58]

With this single statement, Bohm nicely demonstrated the consupponibility of *materialism*, *causality*, and *infinity* while implying that *uncertainty* is strictly a statement about the subject-object relationship. With this, Bohm systematically destroyed the case for Laplacian determinism, not from the indeterministic perspective characteristic of Heisenberg and the so-called "Copenhagen" school, but from a revolutionarily new deterministic view. He rejected entirely Einstein's dream of a single equation that would describe the fundamental characteristics of the universe, allow perfectly accurate prediction, and thus lead to absolute ***certainty***. As Bohm pointed out, "there is no real case known of a set of *perfect* one-to-one causal relationships that could in principle make possible predictions of *unlimited* precision."[59] Finally, "we do not expect that any causal relationships will represent *absolute truths*; for to do this, they would have to apply without *approximation*, and unconditionally."[60]

Uncertainty states that no matter how good our measurement of real objects, an improvement in precision is always possible, although perfect precision is not. There is always yet another cause that will explain part of the variation, but because the number of causes is infinite, some variation, some uncertainty, will remain.

The consequence for practical science is that no relationship between real objects is strictly linear.[61] That is, the plot of one real variable against another real variable really cannot give a perfectly straight line. In simple mathematical terms, when we say that some result or effect, z, is a function of causes x and y (i.e., $z = f(x,y)$), what we really mean is that: $z = f(x,y, \ldots ?)$. When we are asked, "What is the cause of the variation of z?" we say "factors x and y," ignoring the infinite number of other factors because we simply do not know about them or we feel they are unimportant for practical purposes.

As Bohm reiterated, "every real causal relationship, which necessarily operates in a finite context, has been found to be subject to contingencies arising outside the context in question."[62]

We can always add a finite number of these causes or conditions to an expanded study, but obviously, we cannot add an infinite number of them. As a result, "science is never in a position completely and exhaustively to explain the problems it has to face … the solution of one problem only unveils the mystery of another. We must accept this as a hard-and-fast irrefutable fact."[63]

And, as Weinberg put it, "If we want to learn anything, we mustn't try to learn everything."[64] We must focus on the main features of an object and its environment. We can always include additional features for consideration, but we can never include all features, for they are infinite in number. Thus, *uncertainty* is correctly expressed as a subject-object relationship: *it is impossible to know everything about anything, but it is always possible to know more about anything.*

Indeterminism: Uncertainty Is Objective

For modern Aristotelians who believe that some events may not have material causes, there is only one way in which to view uncertainty: as an inherent characteristic of object-object interactions. Thus, according to this Copenhagen view, we are to "consider indeterminacy in the conditions of material bodies as an objective state of affairs."[65] To maintain logical consistency, the flip side of this particular indeterministic coin requires the hubristic belief that "this indeterminacy is not caused by the limitation of our mental horizon to some specific segment of the world."[66] According to the Copenhagen school, the uncertainty concept has nothing to do with how we see the world. It is not a problem of our trying to squeeze infinite information into finite equations. The failure of Laplacian determinism is not "because our descriptions are in need of correction, but because there is always in nature a certain … indeterminacy."[67]

Today both the determinist and the indeterminist pretty much agree that the perfectly accurate predictions promised by Laplace, Newton, and Einstein are impossible. The limitations of trying to view the infinite universe from a single point inevitably intrude upon the debate. Either uncertainty is objective and causality is subjective or vice versa. The indeterminist urges us to "formulate the principle of causality in all strictness as a proposition concerning cognitions, instead of trying to understand it as one concerning things and events."[68]

This subjective view of causality is really ***acausality*** in disguise. Occasionally it ends up stark naked, as in the comment by Reichenbach that "the relations controlling unobserved objects violate the postulates of causality"[69] or in the one by J. D. Fast that "there is nothing in nature to which a definite position *and* definite velocity can be simultaneously attributed, because no particles, in the classical meaning of the word, exist."[70]

At the least, the subjective view of causality denies the connection between motion and causality. At the most, it exhumes Berkeley to deny the existence of the very objects to which the motion refers.

As mentioned in the previous section, subjective causality is essentially specific causality. By definition, whatever is included in the humanly constructed causal law is causal; whatever is not included is acausal. While extremists might be satisfied with that, moderates generally prefer other terminology. They realize that, at least in the macroscopic world, additional investigations often lead to the development of causal laws for phenomena formerly considered acausal. Historically, this has been the way in which the indeterministic position has been eroded. Thus, indeterminists have sought ways in which to put an end to the dissipation of their claims. The Copenhagen interpretation of quantum mechanics seemed to reach such an endpoint, becoming a major contributor to the resurgence of indeterminism in the twentieth century.

On the other hand, if there is to be a renaissance of determinism, the Copenhagen interpretation must be discarded. The choice to be made is becoming more clear. The deterministic position, as long as it includes Bohm's concept of infinite universal causality, remains unchanged with the development of knowledge. The indeterministic position on uncertainty as an objective state of affairs, however, yields to every increase in knowledge. What is at first regarded as uncertain and acausal later may be regarded as certain and causal. Catastrophe theory and chaos theory are examples.[71]

Chance

In lay terms, *uncertainty* is more commonly associated with the concept of *chance*. Chance, however, may be viewed in one of three ways:

1. As a sign of ***acausality***
2. As a singular cause
3. As a sign of observer ignorance

Is Chance Acausal?

Indeterminists traditionally consider the unknown and unobserved as signs of ***acausality*** in the universe. The uneducated frequently regard rare, unlikely events as "miracles." To believers, the stain on the window in the shape of a favored deity is a sure sign of the immaterial hand of the supernatural. In this regard, Aristotle became the greatest of all sinners when he appended the word *absolute* to the word *chance*. Like his less enlightened associates, Aristotle gave up on *causality* just as soon as his knowledge ran out. When indeterminists speak of *luck*, *fortune*, *fate*, or *chance*, they tend to forget that there are causes for the events described by these words. Like other primitive ideas, the belief that chance is acausal is destroyed by knowledge.

Is Chance a Singular Cause?

One would think that in science, at least, the belief in chance as a sign of ***acausality*** would have disappeared long ago. Not so. Supporters of the Copenhagen view did not see chance in quantum mechanics as a matter of ignorance and many of them did not regard it as acausal. On the contrary, they tended to view chance as a singular cause. Clues to the development of this widely held belief reveal its kinship with Aristotelianism, Laplacian determinism, the limitations of mathematics, and the abiding search for certainty. The Heisenberg Uncertainty Principle was destined to trigger a revolution in physics, but its immediate effect was a counterrevolution. The concept of finite universal causality that it destroyed was deeply ingrained. As always, scientists continued their practical search for certainty for the complete description promised by Newton. As with Einstein, the belief in its ultimate success continued as a matter of habit. Thus Bohm's theory of infinite universal causality met with little acceptance. Mathematics, promoted as the language of mature science, could never develop a dialect of infinite length. Rather than adopt an assumption that defied mathematical treatment, the sophisticated members of the Copenhagen school took a step backward—toward Laplace. Regarding chance as a singular cause could preserve the illusion of certainty.

This was advantageous to those who shunned an overt association with the notion of ***acausality***. Above all, it satisfied the demand for completeness and was consistent with the atomistic idea that the quantum was indivisible and that all quanta were identical. Through the special pleas engineered by the Copenhagen school the microscopic realm could be considered a contravention of *uncertainty*. And even if Bohm's hypothetical "subquantic states" were eventually discovered, the argument still could be used against the inevitable future hypothesis of "sub-subquantic states."

The notion of chance as singular cause grew out of the reductionistic practice of lumping the probabilistic aspects of an analysis within a single category. Instead of the Bohmian equation z = f(x,y, … ?), we get the neo-Laplacian equation z = f(x,y,C), where C includes all of the infinite number of poorly known factors under a single category referred to as "chance." The property, z, is then regarded as a result of only three factors, x, y, and C, in much the same way that the Laplacian determinists had insisted. In narrative the concept of chance as singular cause appears like this: "The origin of a body like the Earth depends exclusively upon chance plus the properties of the elements … and the other known factors."[72]

Whether one accepts such a description as complete depends on one's view of the concept of chance. If chance is viewed as we view it in the assumption of *uncertainty*, then it must be multiple instead of singular. Only in the crudest sense is a description containing "chance" complete. As long as further investigation can yield additional knowledge regarding the causal factors lumped under "chance," a description or theory is not complete.

The Heisenberg Uncertainty Principle and quantum theory provided a grand opportunity for indeterminists to promote the Aristotelian notion of chance as singular cause and once again announce the successful conclusion of the search for **certainty**. Theorists of the Copenhagen school felt sure that, at least in the microscopic realm, a nonamendable theory had been found. Construed as a singular cause, the concept of chance did what indeterminists had always wanted to do: call a halt to scientific activity—the establishment of cause and effect.

Still, there was the standard deterministic objection: "To assume that a frustration of present knowledge, even one that looks permanent, is a sign of chance in nature is both practically uncourageous and theoretically a *non sequitur*."[73]

True enough, but at the time that the Copenhagen school made its greatest inroads, physics was fast becoming, as some would say, "overly" mathematized.[74] "Practice" in modern physics increasingly became mathematical practice rather than experimental practice. The demands of mathematics for finitude produced, in the heads of twentieth-century physicists, a finite world far removed from the relentless infinitude of reality.[75]

The common sense gained through "hands-on" experience with the macroscopic realm gave way to a plethora of equations about the microscopic realm. With its mechanistic assumption of *finity*, the Copenhagen interpretation of the Uncertainty Principle claimed to do what the classical mechanists had always wanted to do but could not: eliminate the admission of ignorance from explanation. With waveforms and probability distributions, physicists perfumed the garbage dump of the unknown and resurrected Aristotle's absolute chance.

Whether considered acausal or singular cause, chance was once again credited with mystical powers. In the name of chance, the public has had to endure outrageous fantasies masquerading as science. Sir Arthur Eddington, ever on the lookout for an opportunity to spread indeterminism, could seriously propose the idea that objects would have a certain remote possibility of disappearing into thin air simply because the atoms within them undergo motions ascribed to "chance."[76]

Continuing in this vein, Eddington promulgated the ridiculous notion that, given enough time, and enough monkeys and typewriters, the monkeys would eventually type all the great books. By "chance" they would eventually hit all the keys in the correct sequence. These bizarre extrapolations invariably emphasized calculations showing astronomical, but never impossible, odds. Their philosophical purpose was to divert attention from the real conditions under which real events happen.

Throughout the twentieth century, even serious scientific explanations resorted to the concept of chance as singular cause. A classical example concerns the origin of life on Earth. Reichenbach once declared that "the laws of probability … eventually produce higher and higher forms of life."[77] Jacob Bronowski, the great popularizer of science, reiterated the same antiquated view: "The manifestations of life … must contain a large element of the accidental."[78] Similarly, the normally perceptive Carl Sagan wrote, "The evolution of life on Earth is a product of random events, chance mutations, and individually unlikely steps."[79] But chance, being no more than observer ignorance, can produce nothing at all. There are reasons for each so-called "accident" or "random event" that make it highly likely—indeed, the only possibility under the conditions, however unique.

Is Chance Ignorance?

The preferred definition of *chance*, according to Webster's dictionary, is "something that happens unpredictably without discernible human intention or observable cause."[80] A major purpose of education is to eliminate as much guesswork as possible. The more we know about a system and its relationship to its environment, the less we need to use chance in describing it. In the parlance of scientific research, what we know rather definitely may be described by deterministic models, while what we know only vaguely must be described by probabilistic models. The laws of probability used in developing probabilistic models are merely tools for delimiting what we know and what we don't know. As our knowledge increases about a thing or an event, as we include more and more of the infinite number of causes of certain effects, the knowledge component of the relationship increases and the ignorance component decreases. But ignorance always remains. Some variation—some uncertainty—always exists in every prediction. Indeterminists can forever point to this uncertainty and claim it as an indication of acausality, but determinists, accustomed to removing successive layers of ignorance and of developing knowledge from what once was mystery, will not be impressed.

The conversion of the "probabilistic" into the "deterministic" through investigation can be illustrated by a commonplace example. Almost all probabilistic models use a variant of the normal distribution or "bell-shaped curve" for describing a property of a particular class of objects (Fig. 3-2). In our hypothetical example, animals classed as dogs have been weighed, their weights have been plotted on the horizontal scale, and the frequencies of the various weights have been plotted on the vertical scale. The result is a bell-shaped curve that tells us that dogs weigh about fifteen kg on the average and that their weights range from less than a kilogram to more than thirty kg. Such general information, of course, is of extremely limited usefulness in making certain predictions. For instance, it would not give us a very precise estimate of the weight of the next dog we will see on the street. About all we can say is that there is a greater likelihood that this dog will weigh around fifteen kg than, say, around three kg or forty kg. Our state of ignorance about what the dog will be like is so great that we must use statistics, probability, or "chance" in discussing its weight.

People who consider the dog as a "system," isolated from all else, most likely would throw up their hands and remark something like "Your guess is as good as mine." At the most, they would be forced to use the entire bell-shaped curve (Fig. 3-2) in making their estimate. Logically, they would bet that the next dog seen on the street would be of average weight—something around ten to twenty kg. Those more scientifically inclined, however, would increase the odds in their favor by recalling that dogs are really not isolated from their environments. By knowing more about how a dog's size relates to its environment, we can eliminate some of the "chance" indicated by the large standard deviation in Fig. 3-2.

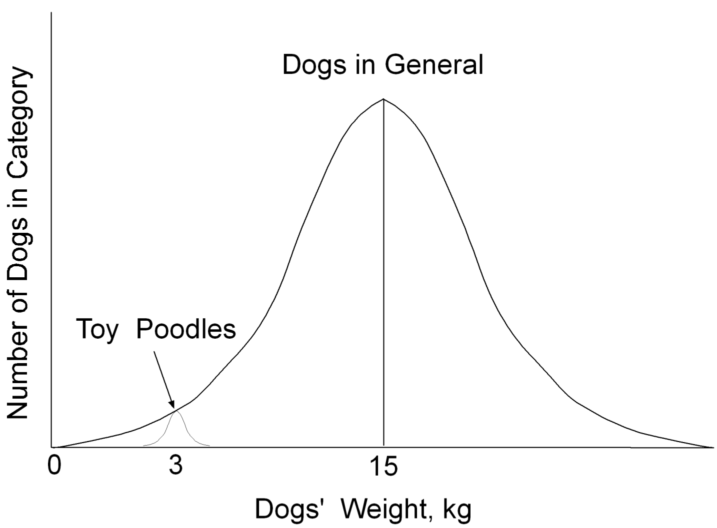


Fig. 3-2. Hypothetical distribution of dogs' weights.

Suppose that we talk with someone on the street and find that a neighborhood is noted for its annual Toy Poodle Show. We might infer that there is a good reason for the event being held in this particular location. A nonscientist might see absolutely no possibility of a relationship between annual toy poodle shows and the sizes of local dogs. After all, some people travel hundreds of miles to dog shows. Scientific investigators, however, play such guessing games all the time. They realize that, more often than not, related systems exist nearby rather than far away. Human beings and their cultural paraphernalia follow the same pattern.[81]

We know that toy poodles are smaller than most dogs and we also know that the variation in weight for adult toy poodles is less than for dogs as a whole. If we investigate further and find out that the apartments in the area allow only “lap” dogs, then this information further reduces the element of chance in our guess about the weight of the next dog we will see on the street. Adult toy poodles have weights between three and four kg. By weighing a large number of them, we could get another bell-shaped curve. Of course the width of the bell will be tiny compared to the one for dogs in general (Fig. 3-2).

In this way, more and more “chance” is removed as we learn more and more about the dog whose weight we are about to guess. When the dog actually appears and we see that it is a male poodle and that he appears fat instead of thin, we have eliminated even more “chance.” Next, we might remember that it is 10:15 AM, the time when Mrs. Smith, who is very punctual, takes her grand champion poodle out for a walk. And, oh yes, last year the grand champion at the Toy Poodle Show weighed X amount. We could continue on and on, decreasing ignorance and “chance” with every step, but never eliminating it altogether.

The process illustrated above is typical of the scientific method and of the development of all knowledge. Based on a limited amount of knowledge, we guess at the possible relationships between things, subject our guess to further observation or experiment, and then accept or reject the guess for use in making still more guesses. This view of chance as a subject-object relationship also helps us understand the nature of knowledge itself. Knowledge and ignorance must be seen as relatives; knowledge is nothing without ignorance.

We may congratulate ourselves for being on the scene at exactly 10:15 AM and for having guessed the dog’s weight in the above example, but the guess could not be perfectly accurate. Even if our estimate is within 0.1 kg, there is still infinite detail to be discovered in that last 0.1 kg. We would find that a dog’s weight fluctuates with such normally trivial factors as temperature, relative humidity, and the growth and activities of parasites and microorganisms. Finally, a living creature’s weight fluctuates with each breath it takes. Minutiae such as these should dispel any notion that a dog’s weight is the result of a finite number of causes.

No matter what level of detail we reach, the infinite character of the world produces an uncertainty in every analysis. Each data point and each "constant" determined from real objects and their motions has a plus and minus associated with it. A good analyst knows that expending further effort to eliminate major causes of variation can reduce this variation. But all variation cannot be eliminated, for two reasons: 1) increasing effort is required to determine and to remove ever more insignificant causes of variation, and 2) the system itself, as well as its environment, is in constant motion—a fact that became inescapable in Heisenberg's consideration of the microscopic realm. During the period in which the causes of some of the variation are being discovered, the system and its environment change in ways that present new variations requiring further discovery. According to *uncertainty*, there can be no system—macroscopic or microscopic—that does not necessitate a continual updating of our knowledge about it.

Uncertainty and the Unknown

With the assumption of *uncertainty*, scientific philosophy shows its potential for developing a refreshing and liberating view of the universe. While it necessarily must be somewhat dogmatic in holding its assumptions, it need not be absolutely dogmatic. While it continually searches for certainty and for knowledge, it need not claim that absolute ***certainty*** and absolute knowledge can be found. The universe is far too complex for claims that any part of it could be described in full or its motions predicted in complete detail. Wherever we discontinue our describing or theorizing, whether it is at the point where indeterminists would call the rest of what we do not know "chance," or at the point where exhaustion overcomes us, let us admit our ignorance. The potential for knowledge is infinite.

Every theory has within it a time bomb that eventually destroys it—the Laplacian "assumption that all physical factors (mass and/or energy) which enter into a reaction are known, that all possible parameters have been defined."[82] The Aristotelian belief in chance as singular cause only gives one a false sense of certainty. It invariably associates chance with knowledge rather than with ignorance. The question of the nature of chance is basic to an understanding of science. It will continue to arise again and again in the pages to follow. In all of science, a special effort must be made to avoid using words such as *chance*, *accident*, *random*, or *luck* as indications of anything other than observer ignorance. To do so would be a violation of the Third Assumption of Science, *uncertainty*.

The Fourth Assumption of Science: Inseparability

Just as there is no motion without matter, so there is no matter without motion.[83]

In effect, *materialism* posits matter and *causality* posits motion. The Fourth Assumption of Science declares the essential connection between the two concepts. Like *materialism* and *causality*, *inseparability* seems mere common sense. How could anyone speak of motion without acknowledging the existence of the thing that moved? How could anyone, at this late date, speak of motionless matter? But the opposing assumption, ***separability***, does just that. It has always been one of the venerable underpinnings of indeterminism.

The idea that *all* portions of the universe are in motion relative to every other portion would have been inconceivable in primitive society. Indeed, to the primitive, most objects appeared motionless and those that did not seemed to move as though by some supernatural power. The presupposition that later gave rise to the indeterministic assumption of ***separability*** exploited an unavoidable conceptual difficulty. The results were as fantastic as the physical connection between matter and motion was difficult to prove. From ***separability*** we get our rich heritage of immaterial "things" and "beings" nevertheless presumed capable of motion. Without ***separability***, souls, ghosts, and gods would find no place in the universe. Even within science, the residuum of related ideas persists. Aided by the impossibility of conceptualizing both matter and motion at the same time, ***separability*** seems to give everlasting life to indeterminism.

From the very beginning, the belief in determinism was inextricably associated with the belief in the connection between matter and motion. From Democritus in the fifth century BC to Spinoza and Hobbes in the seventeenth century, deterministic philosophers presented the view that the existence of matter and the occurrence of its motion relative to other matter were natural, not supernatural.

As always, the more intensive and varied one's experience with the material world, the more doubtful are indeterministic notions, particularly of **separability**. The Industrial Revolution, in particular, stimulated the desire and the necessity for a hands-on approach to understanding things and their movements. With the development of machines came the need for a general theory of their operation. This was met in 1687 when Isaac Newton published the *Principia*, thereby laying the theoretical and mathematical foundation for the science of mechanics. Being much concerned with objects and their motions, this new methodology unavoidably spread the newly evolving notion of *inseparability*. The practical success of mechanics, even in fields removed from the industrial arts, promoted the first reasonably consistent version of the scientific worldview: mechanism. "Mechanism" took its major cue from *inseparability* and advanced the revolutionary conviction that the universe consists solely of matter in motion.

None of this occurred without an intense struggle. Indeterminists found mechanism easy to criticize. The term itself conjured images of noisy, dehumanizing contraptions in a polluted atmosphere of smoke, grease, and oil. Sophists regarded the reduction of the infinite complexity of the world to two conceptual categories as hopelessly crude. Nevertheless, this idea, born of such lowly parentage, swept the intellectual world, becoming the guiding light of science until the twentieth century. From the motions of the planets to the manifestations of consciousness, nothing was too complicated for the explanations of a Holbach, Büchner, or Loeb, who promoted mechanism and its underlying, stillborn assumption of *inseparability*.

But as mentioned previously, the reign of the old-time mechanists ended with the death of Laplacian determinism. Classical mechanism was hoisted on its own petard. To support their claims that complete explanations were possible, mechanists had to concede an end to the motion they began with. It was impossible to give a perfectly complete description of systems that changed even before the describing was done. Instead of admitting this, mechanists tended to revert to atomism, the belief that objects are immutable and therefore completely describable and entirely predictable. In supporting finite universal causality to the bitter end, classical mechanism ended up denying the protoevolutionary idea that gave rise to its birth.

Unfortunately, the overthrow of mechanism has placed *inseparability* itself in doubt. During the transition from a Laplacian to a Bohmian variety of determinism, we seem to have lost our way. Once again, we must suffer tales of matter without motion and of motion without matter. In addition, we are confronted with a new twist: the claim that matter *is* motion and that motion *is* matter. To find the scientific path again, we must disinter *inseparability*.

The Inseparability of Matter and Motion

If any topic can be said to be ultimately unfathomable, it is the "relationship" between matter and motion. In the strict sense, we cannot even speak of such a relationship because relationships occur only between "things"—portions of the universe. As I argue in this section, motion is not a "thing," despite what we must say about "it." Movement cannot be a "part" of the universe because it is the activity of parts of the universe, not the parts themselves. It is really not legitimate to ask, as some have,[84] how matter and motion are connected, because that would be treating motion as a thing, as matter, which it is not. The unity of the world consists of there not being a *physical* distinction between matter and motion,[85] even though its correct explication necessarily requires a *conceptual* distinction.[86] The philosophical issue cannot arise unless one insists on a physical as well as a conceptual distinction as indeterminists are wont to do.[87]

The philosophical issue was supposedly put to rest with the equation that made Einstein famous: $E = mc^2$. Defined here as the mathematical product of matter and motion, the concept of energy was to guarantee physical *inseparability* for all time. But has it? How many people really understand that the conceptual unification that Einstein was trying to achieve is, in the end, impossible? Einstein's mathematization of the energy concept could not and did not prevent the conceptual vulgarization of matter-motion to *either* matter *or* motion. His belief in ***finity*** led to the conceptual and mathematical closure that gave him the equation, and along with it several mystifications for the enjoyment of indeterminists everywhere.

Intuitively, we know that there is a big difference between matter and motion. The phenomenon of "legs" and the phenomenon of "running" cannot be conceived as identical no matter how much we try. The common sense despised so much by modern physics nevertheless cannot consider "running" to be material in the same sense that "legs" are considered material. "Running" does not have existence in the sense that "legs" have existence. One can possess legs, but one cannot possess running. Running is what legs do; motion is what matter does.

Under *materialism*, we assumed that the universe consisted of matter, and that all things, being portions of the universe, were examples of matter. All portions of the universe have dimensions and, therefore, have existence. Strictly speaking then, motion per se does not exist; only things, only matter can exist. There is no place left in the universe where motion could exist. What then, *is* motion if it is not a thing, does not have existence, and is not independent of matter? As mentioned, motion is what matter does. We know, as Einstein emphasized, that each portion of the universe continually changes position relative to all other portions of the universe. The fact that this occurs is as sure as the fact that matter exists.

Furthermore, neither matter nor motion should be considered more important than the other; both are "primary." Motion cannot occur without matter and matter cannot exist without motion. Or, as Hegel put it, "Just as there is no motion without matter, [so] there is no matter without motion."[88]

While the first part of Hegel's dictum is relatively easy to understand, the second part is not. For many people the deduction does not follow from the premise. But if one agrees with Engels that "matter is unthinkable without motion,"[89] then Hegel's statement is the way in which *inseparability* must be understood. What gives an object its materiality is, first, its consisting of other objects in *motion*, and second, its existing among other objects in *motion*. As we shall see later, when we inquire, in turn, after these objects, we get the same answer. The question "What is matter?" goes begging into *infinity*. In deterministic usage, motion always refers to an object that is moving relative to other objects that may or may not be explicitly mentioned. Again, the existence of objects is possible only because they are moving relative to objects outside them and contain other objects that are moving inside them. Matter and motion form the basic, inseparable, but nevertheless dialectical unity.

Classical Mechanism

Although the defeat of mechanism was engineered primarily by determinists, the spoils were reaped by indeterminists. In 1927, the great worldwide economic expansion, to which indeterminism was to owe its revival, had barely begun. The legitimate complaints of determinists were answered by a mishmash of new mathematical formulation and ancient superstition that met with ready public and governmental acceptance. The deterministic part of the testimony against classical mechanism was as follows.

Deterministic Critique

As mentioned, in their battles with supernaturalism, mechanists went so far as to promise a complete description of the world. They attempted to answer the indeterminists' demands for proof by asserting that a final proof was possible. When Heisenberg showed that such *certainty* was not forthcoming, mechanism lost its title as the scientific worldview.

Because mechanism prevailed so long as the guiding philosophy of science, it accumulated an enormous indeterministic burden. Today's deterministic critique of mechanism amounts to a critique of old science and old beliefs that either were indeterministic to begin with or were, like the doctrine of absolute chance, the results of compromises with indeterminism. Except for *materialism* and, to a certain extent, *inseparability*, the assumptions held by classical mechanism stand in opposition to the currently evolving scientific worldview. I will mention only a few of the major indeterministic aspects of classical mechanism.

First, mechanism has been historically and curiously associated with a static rather than a dynamic vision of the world.[90] This association developed in spite of the fact that the concept of motion sponsored initially by mechanism is as much a part of *inseparability* as is the concept of matter. In practice, however, any model of the real, dynamic world would have to be static in comparison. Engrossed in their static models, mechanists tended to overemphasize things rather than processes.[91] Along with the static view came the overemphasis on isolation and **reversibility**.[92] Instead of being dynamic and progressive, classical mechanism became static and conservative.

Second, classical mechanics, to which mechanism was tied, was restricted to mechanical terms such as *mass*, *force*, *velocity*, and *acceleration*, which allowed for only simple models. In keeping with their static, finite nature and simplicity, these models did not allow for evolution.[93] In the last analysis, the motion they did permit was external to the models themselves. It made little difference whether the objects of concern were considered filled with the mysterious substance called "matter" or devoid of matter altogether. The mathematical methods of classical mechanics implied that the whole was equal to the sum of its parts. Although such an approximation was sufficient for many engineering feats, it was inadequate for rapidly evolving systems—those more clearly in motion within and without. As a consequence, the rigidity of classical mechanism made it practically worthless in the social and biological sciences that began to grow explosively early in the twentieth century.[94]

Indeterministic Critique

The crux of the indeterministic complaint against mechanism always has been that there is more to the universe than matter in motion. The epithets rained down upon the mechanists who refused to leave room in their philosophy for the supernatural and its aficionados. Indeterminists made a philosophical space for themselves by denying the universality of the mechanical view. They only needed to point out that the analogy between machines and other systems was grossly inadequate. They could feel great indignation when the analogy was extended across the Cartesian line. For these folks it was usually enough to deride the "crass materialism which views reality as matter in motion."[95] If that didn't work, then the concepts of matter and motion could be cheapened and restricted in other ways.

Through the centuries, the slander of the concept of matter was so intense that its position as a pillar of science was continually in question. So it was that faint-hearted scientists of the late nineteenth century moved to disown matter and adopt pure motion instead. What began as a legitimate attack on its rigidity became an escape from mechanism via the newly developing concept of energy.[96] Indeterminists clamored for an outright substitution of energy for matter. Perhaps the greatest advocate of the switch was Wilhelm Ostwald, a physical chemist, who believed: "The ultimate goal of science is now presented as the task of establishing a worldview consisting purely of energy concepts, without the use of the concept of matter."[97] Staunch materialists vehemently criticized this anti-mechanistic use of the energy concept, but, as we will see in the section after next, this usage is still very much with us.

Doubts about the concept of matter, and in particular, its interconnection with the concept of motion are nothing new. It was to be expected that these doubts would become especially prevalent when simplistic, finite mechanism was yet to be replaced by a sophisticated, infinite form. Today, indeterministic scientists attack *inseparability*, not so much by denying the concept of matter, or the concept of motion, but by denying the universality of the *inseparability* of the two. The logical results of this denial once again are the dubious and inexplicable notions of matter without motion and motion without matter. Both are attempts to negate *inseparability* and deserve illustration in some detail.

Absolute Zero: Matter Without Motion?

As an alternative to *inseparability*, the concept of motionless matter has enjoyed a long and unfruitful career. At first the Earth itself was thought to be motionless, the center of a universe bounded by the fixed stars. But then, one after another, portions of the universe were shown to be in constant motion relative to each other. Since 1960, even the continents are officially recognized as being in motion with respect to each other. In every instance, the idea of matter in motion triumphed over the idea of matter without motion. On this point, Heraclitus remains victorious.

Why then, after so many defeats, hasn't the notion of absolute rest been put to rest? The reason lies in the fact that *inseparability* is an assumption, and although, like *causality*, it has passed numerous tests, it cannot be tested in the infinite number of cases that would be required to remove all doubt. Many of the motions of matter appear so slow that, to the naïve realist, they seem absolutely at rest. For instance, that great symbol of stability and permanence, the Rock of Gibraltar, at first glance appears to be completely motionless. To the sailors passing by, it is the ship that is in motion, not the Rock of Gibraltar. But we know that Gibraltar is part of a revolving and rotating planet and that it is composed of billions of atoms in which still more billions of electrons revolve around each nucleus a million billion times a second.

Until such detailed knowledge was obtained through scientific investigation, philosophers could assume with the atomists that, although the atom itself was always in motion, whatever was inside the atom was not. A similar view still exists concerning other aspects of the motions of atoms, especially those occurring near absolute zero.

Any challenge to a fundamental assumption of science had better be made in an area where experimental evidence will be forever incomplete. The indeterministic interpretation of absolute zero is a good example of the modern-day rejection of *inseparability* through the hypothesis of the existence of motionless matter.

Such shenanigans were prominent throughout the twentieth century, where they achieved a new height in absurdity.

The theory of absolute zero concerns heat, usually defined as the vibratory motion of individual atoms of the elements. The measurement of temperature is the measurement of the rapidity and magnitude of this vibratory motion. If an atom had no vibratory motion, it would exhibit no temperature. Ideally, we would call this temperature—or lack of temperature—absolute zero. I say "ideally" because in reality, no one has ever observed absolute zero. Claims have been made, but all these require an indeterministic interpretation of the Third Law of Thermodynamics.

Essentially, the Third Law "precludes the attainment of the absolute zero of temperature in a finite number of steps."[98] According to *inseparability*, the absolute zero of temperature would imply the absence of matter as well as the absence of motion. Although absolute zero (about-273.15 degrees Celsius) may be a useful idealization, it is a mistake to speak of matter *at* absolute zero, because matter could not exist at that temperature. That is, it could not exist without being in motion. No experiment, which necessarily must be done in a finite context, could descend an infinite number of steps to finally achieve the "temperature" at which matter in motion does not exist.

As might be expected, the indeterministic interpretation of the Third Law generally confuses ideality with reality. It assumes that matter could actually exist *at* absolute zero, undergoing no motion, and having *perfect* order (zero entropy) and *perfect* crystallinity.[99] Even those who know that absolute zero cannot be obtained in a finite number of steps seem compelled to write in contradiction "the absolute zero of temperature means no motion of the molecules."[100]

But it is indeterministic nonsense to dream of molecules actually at absolute zero. As mentioned, the atom itself consists of other objects in continuous motion. The electron path, which in any case is not perfectly circular, helps define the shape of the atom and varies from one revolution to another. The nucleus, too, responds to the position of the electron at any moment and therefore must wobble, as do the parts of a planetary system. A non-vibrating atom is, therefore, inconceivable.

It has been well established that entropy (amount of apparent disorder) *approaches* zero as the temperature of a substance *approaches* zero. In general, gases become liquids and liquids become solids as temperature decreases. Matter usually exhibits an increasingly well-ordered and generally more compact structure as it loses motion. For practical calculations in thermodynamics, the assumption that entropy is approximately zero near absolute zero is legitimate even though absolute zero is unreachable. Illegitimacy arises only when we incorrectly assume that the success of the approximation indicates the actual existence of the ideal.

Even G. N. Lewis and Merle Randall, the great authorities on thermodynamics, contributed to the confusion with this statement appearing in their classical text: "Every substance has a finite positive entropy, but at the absolute zero of temperature the entropy may become zero, and does so become in the case of perfect crystalline substances."[101]

A logical consequence of this idealistic interpretation is the mistaken belief that the Third Law could "lay claim to perfect exactness."[102] Since Lewis and Randall sanctified it, others continue to speak of "crystals at absolute zero"[103] or perfection "near absolute zero."[104] We are to believe that "at the absolute zero of temperature … all thermal motion in a solid ceases and there can be no disorder due to lattice vibrations or other atomic motions."[105]

Such indiscreet statements leave the impression that absolute zero actually could be obtained, that motion then would cease, but that matter would somehow still exist—that matter without motion would be possible. We are seldom given much insight into the nature of such matter. Presumably, we must bring back the old conception of atoms as hard little balls that were once considered the ultimate constituents of matter. Perhaps that is what one commentator meant when he implied that "only at absolute zero would they be pure atoms."[106]

Such sophistry in evading the Fourth Assumption of Science led to a "remarkable break through" by W. G. Proctor.[107] Proctor suggested that matter really can exist at absolute zero because of "quantum mechanical considerations" further chasing the indeterminism into shadows where few dare to follow. After assuming that absolute zero had been achieved experimentally, Proctor even claimed to have discovered negative temperatures. By his own admission, however, "The experimental results run counter to a strong sentiment that temperature, like volume is something intrinsically positive."[108] Indeed, for those who believe that absolute zero can be achieved in the laboratory, the positivity of temperature must not be the only deterministic sentiment with which they have difficulty. Proctor's speculation on negative temperature actually applies a double whammy to *inseparability*. Not only is matter seen here as motionless, but its motion rises ghostlike from its corpse. From matter without motion we are led to motion without matter.

Energy: Motion Without Matter?

Ostwald's dream of replacing villainous matter with angelic motion is today being realized in the common mystification of energy as motion without matter. The situation has gotten so bad that even indeterminists have complained that "Physics has discarded matter, but has supplied no substitute."[109] As mentioned, *energy* is defined as the product of mass times the velocity of light squared—an attempt to account for both matter and motion at the same time. But the mere multiplication of a term for matter and a term for motion really does not guarantee their conceptual unification any more than the designation of matter and motion as separate terms guarantees their physical independence.

Energy and other matter-motion terms are easily misused because it is impossible to conceive of matter and motion as separate entities. We can observe matter *in* motion and the motion *of* matter. It is self deceptive to claim, as some do, that we can conceive of a thing as if it were motion and motion as if it were a thing. Legs are not motion and running is not matter. The inherent failing of a matter-motion term is its tendency to subsume the connotations of matter at one time and those of motion at another, often unbeknownst to the user. Either way, the indeterminist can exploit the resulting confusion as a way of opposing *inseparability*.

The fact that energy is a mathematical term for matter-motion is forgotten in the all-too-common, but misleading, view that matter is equivalent to energy.[110] This cannot be true because the term for matter (mass) in Einstein's equation never appears without the term for motion (velocity of light squared). It is forgotten again when energy and matter are viewed as mutually exclusive or as opposites.[111] This forces energy into the motion category, to which it is no better suited. These ambiguities are not resolved by lengthy exposition[112] and only demonstrate the difficulty of comprehending matter and motion as a singular phenomenon.

The concept of energy thus plays a unique role in science and philosophy. Determinists can see it as an admirable, if inevitably flawed, attempt to unify conception and reality. Indeterminists can see its failure to do this as a proof that their necessarily divisible conception matches a divisible reality. Instead of supporting *inseparability*—the idea that matter and motion are conceptually intertwined—the concept of energy has encouraged the opposite view, that matter or motion might be found physically independent of each other.

The idea that energy is motion without matter was natural for the positivistic approach to science that grew alongside the concept of energy. At the microscopic level of observation in particular, it is not uncommon to find evidence for motion without the corresponding evidence for its material carrier. At such a juncture one can *assume*, with the Fourth Assumption of Science, that the carrier exists, or one can *assume*, along with the "unassuming" positivists, that until one is found, a carrier does not exist. In the latter case, energy takes on a ghostly form unsuited to definition.

For example, physicists recognize the "flow" of heat as the mechanical transfer of motion from molecule to molecule within solid bodies. But when this same motion appears as infrared radiation, it is considered neither as matter, nor as the motion of matter, but as matter-motion, a mysterious, massless wave-particle capable of traveling through "empty space." In contrast, these same physicists hold a clear view of other types of motion. Sound, for instance, is not considered matter or matter-motion. It is the motion of matter. Sound may undergo a similar transmission from a solid body to its gaseous surroundings without losing its character as motion. No one seriously dreams of the fantastic conversion of sound from motion into matter-motion, and yet this is exactly what is imagined in the case of heat motion. The result is the familiar conceptual muddle.

Duality can occur only between the concept of matter and the concept of motion, not between matter and motion itself. In thinking and writing about motion, we are often forced to use nouns instead of verbs although there are no material objects to which the concept applies. We may be forced to idealize matter and motion as if they were distinct entities, but we must never hypothesize their separation in reality. For example, it is nonsense to consider, as the Big Bang cosmogonists[113] do, that the universe was once devoid of matter, consisting only of radiation.[114]

The term *energy* is so frequently confused by its indeterministic interpreters that one may question its usefulness within a philosophical system guided by *inseparability*. I suggest that the term *energy* be avoided whenever the more specific terms *matter* or *motion* could be used instead. Certainly, energy should never be opposed to matter or motion. Unfortunately, neither the term *matter* nor the term *motion* is completely unambiguous either. As explained later, each must be defined in terms of the other. As a noun describing action, the word *motion* unavoidably gives a nominative connotation to activity. Motion ends up being thought of as an entity. Instead of being what matter *does*, it tends to become what matter *is*. These problems are always with us and are best solved through practice in conceptualizing matter and motion.

Conceptualizing Matter and Motion

Hegel's insistence on the physical *inseparability* of matter and motion remains valid today. In reality, matter and motion are one; only in ideality could they become distinct. But, as Joel de Rosnay pointed out, "Intelligence can understand movements or flows only as a succession of juxtaposed still positions."[115] Our sensations come in discontinuous pulses. Vision, for example, is a series of photon impacts that impart information about the shapes and qualities of the material structures before us. The sensation of motion develops in the way in which thousands of still frames in a filmstrip produce a motion picture. Thus we may see matter, but we can only infer motion. Motion cannot be sensed, for it is not a thing. Only things can be sensed.

This is not to say that matter is real and that motion is unreal. Our idea of matter and motion stems from real matter and its real motion. But, as noted before, the idea of existence applies only to matter. Only things exist; events do not. The Declaration of Independence exists, but the signing of it does not. The signing of the Declaration of Independence never "existed," it "occurred." The signing was the motion of matter, not matter itself.

If the first step in science is to distinguish one thing from another, then the second step is to distinguish the thing from what it does. A philosophy based on *inseparability* seeks conceptual clarity by continually making the distinction between matter and motion. It explores the different types of motion as it explores the different types of matter. While it reduces reality to two abstract categories, it nevertheless insists that matter and motion form a basic unity that is concretely and infinitely varied in the types of phenomena it displays.

It always has been difficult to maintain the conceptual identities of matter and of motion while maintaining their physical *inseparability*. It has become especially so with the widespread use of terminology that attempts to combine the two concepts but fails without warning. Fortunately, the basic structure of language can rescue us. In all languages, words refer to things or to what things do. Subjects naturally require predicates; predicates naturally require subjects. By insisting on clear distinctions between matter and what matter does, we can edify ourselves as we renew the language. When matter is being discussed, we can demand to know how it is moving; when motion is being discussed, we can demand to know what it is that is moving.

These questions, no longer pressed by physics, must be asked to produce clear thinking. We must rediscover which words refer to matter and which refer to motion. It is easy to classify "legs" and "running," but there are many words, including some general terms, that have carried the burden of indeterministic obscurantism. I will define and discuss a few of them to initiate the discipline essential for applying the assumption of *inseparability*. The basic strategy is this: separate matter and motion into distinct *conceptual* categories, and after having done so, demand a marriage that will not allow one of them to appear without the other. Finding matter, we will ask, "Where is motion?" Finding motion, we will ask, "Where is matter?"

Table 3-2. Some common alternate terms for the categories "matter" and "motion."

Matter	Motion
Thing	Event
Structure	Function
Mass	Velocity
Space	Time

Thing-Event

All things are matter and all events are motion. In a strict sense, we should not speak of "things occurring," because only events can occur. Things simply exist. An "event" is the convergence or divergence of at least two things.

Structure-Function

Structure and function are particularly common terms in biology and sociology. Even though structure and function are inseparable,[116] entire disciplines have managed to emphasize one or the other as though they occurred independently. Sociology and anthropology, for example, have two philosophically opposed schools: the "structuralists" and the "functionalists." Aside from the delicate connotations and historical nuances developed in the debates between these two groups, it must not be forgotten that, if the starting point is a bogus terminological distinction, then much of the debate and much of the science flowing from it also will be suspect. A discussion between a pure "matterist" (one who believed in matter without motion) and a pure "motionist" (one who believed in motion without matter) would have little more than humor to recommend it. That the word "structure" can be found so remote from the word "function" betrays a rejection of *inseparability* and an indication that the language of indeterminism is being spoken.

Mass-Velocity

As a student in elementary physics I was shocked to find that something as basic as "mass" had no *a priori* foundation. As it turns out, the definition of mass is far from a trivial problem.[117] We must consider mass as matter and velocity as motion. The matter-motion term for mass-velocity is momentum, p. The equation is:

$$p = mv \qquad (3\text{-}1)$$

Where:

m = mass, g
v = velocity, cm/sec

Because momentum is neither mass nor velocity, neither matter nor motion, it is subject to the same conceptual confusion as is the term *energy*. Typically, objects of great mass and low velocity relative to the observer take on the connotations of matter, while objects of small mass and high velocity relative to the observer take on the connotations of motion. In equation 3-1, mass is defined in terms of momentum and velocity, while velocity is defined in terms of momentum and mass—a circular argument made necessary by the reality of their *inseparability*. Just as there is no *a priori* in philosophy, there can be no *a priori* in nature, no absolute mass to which all others naturally relate. There can be no mass independent of velocity, just as there can be no matter independent of motion.

The isolation implied when velocity is stated without a referent simply does not exist. An "object" surrounded by "empty space" would have no mass just as it would have no velocity. Mass, like velocity, is dependent on the existence and motion of other things. While equation 3-1 yields a velocity of zero for an object at "rest" relative to the Earth, its velocity certainly is not zero with respect to other objects in the universe. By keeping the necessity of a referent in mind, equation 3-1 becomes just another way of stating *inseparability*: "objects" without motion relative to other objects in the universe would have no momentum, and by implication, no mass either. They simply would not exist.

Spacetime

Much of modern physics and cosmology concerns the discussion of space and time. The resulting confusion reflects one of the great philosophical struggles of the twentieth century. We will need some carefully honed definitions to make any sense of it. Because the ones I choose here—space is matter, time is motion—will seem counterintuitive to many of you, let me explain my reasoning.

Under *materialism*, we assumed that the universe consists of matter. As mentioned, *matter* is defined as an abstraction for "all things." Everything we are familiar with, and presumably those with which we are not, takes up space. Everything in existence has dimensionality, and therefore volume. If the universe is material, then the volume or space it occupies must be regarded as matter. The term space, used is this way, becomes another abstraction for "all things," i.e., matter. For the determinist, space is something; for the indeterminist, space is nothing.

The ancient, commonsense idea of opposing space to matter as though space was the absence of matter is no longer as useful as it once was.[118] For one thing, pure space has been found nowhere. Experimentally, the closest we have ever come to empty space is a partial vacuum. For another, matter takes up space and would be inconceivable without space. In addition, matter generally is found to consist mostly of what we generally consider to be space. For example, the mass of an atom is almost all located within the nucleus. Its volume is mostly “empty space.” However, when we investigate this so-called “empty space” we invariably find that it is not empty at all. There is always something there.

Only in ideality could matter and space be considered opposites. Perfectly solid ideal matter is the opposite of perfectly empty ideal space. In reality, neither solid matter nor empty space has been found, disappointing naïve realists whenever they discover this fact. All things and their surroundings evince varying degrees of solidity and emptiness. A completely empty universe thus becomes no more conceivable than a completely solid one. Thus Einstein’s definition of space as the absence of matter is mechanistic, not relativistic. It is as obsolete as Democritus’s definition of matter as hard and impenetrable.

Time is motion. In the specific, time is the motion of one thing relative to another thing. In all cases, we measure time by measuring the motion of things. Universal time is the motion of each thing relative to all other things. There can be no separate existence for time, just as there can be no separate existence for motion. The universe is already filled with matter. There is no “room” for motion in the universe and, as we will see much later, it is unnecessary to create another dimension for it. There never was a “time” when the infinite universe did not exist. Speculations about going “back in time” are mere amusements in science fiction. There is no such place.

One might have thought that the development of matter-motion terms in modern physics would have laid ***separability*** to rest. Not true. The conventional view of *spacetime*, for instance, assumes that it can be modeled in four dimensions and treated as matter. But dimensionality is a property of matter; it is not a property of motion because motion does not *exist*; it *occurs*. Like other terms for matter-motion, *spacetime* tends to take on the connotations of either matter or motion at the whim of the user. When an attempt is made to build a model of *spacetime*, the model, being material, tends to give a material connotation to spacetime. When an attempt is made to conceive of spacetime as motion, the concept of the universe tends to become dematerialized. The notion that the universe might be “curved” thus is not far removed from the Berkeleian notion that it may not exist at all.

Inseparability and Clear Thinking

Let me restate. The dialectical nature of the world stems from its character as matter in motion. Its unity consists in the *inseparability* of this matter and its motion. Although matter and motion are not physically separable, it is impossible for the mind to conceive of matter and motion as a singular phenomenon. Although we may invent terms for conceiving of matter-motion as a unity, they inevitably fail, taking on the connotations of either matter or motion, but not both at once. Clear thinking requires us to be cognizant of *inseparability*. Consequently, we must guard against four types of errors of logic that violate the assumption of *inseparability*:

1. That matter could occur without motion
2. That motion could occur without matter
3. That matter is motion
4. That motion is matter

Only by avoiding these indeterministic errors can we achieve a description of the universe that includes both subject and predicate, and is, therefore, both meaningful and scientific.

The Fifth Assumption of Science: Conservation

Matter and the motion of matter neither can be created nor destroyed.

The sentiment underlying *conservation* is ancient. The Greek philosopher Anaximander asserted that matter is eternal and indestructible. The Roman philosopher Lucretius believed that "Never can nothing become something, nor something nothing." Although we have since discovered that the individual units of matter are not as permanent as these early atomists thought, the deterministic notion that the external world has an overall permanence still persists. David Bohm clearly expressed the modern view:

> In nature nothing remains constant. Everything is in a perpetual state of transformation, motion, and change. However, we discover that nothing simply surges up out of nothing without having antecedents that existed before. Likewise, nothing ever disappears without a trace, in the sense that it gives rise to absolutely nothing existing at later times. This general characteristic of the world can be expressed in terms of a principle which summarizes an enormous

> domain of different kinds of experience and which has never yet been contradicted in any observation or experiment, scientific or otherwise; namely everything comes from other things and gives rise to other things.[119]

The alternative to *conservation* is ***creation***, the assumption that material entities can come into being without material antecedents. In its greatest generality, ***creation*** supposes that a rational but immaterial being existed by itself for an eternity before it resolved to create the universe out of nothing. The latest version among those who may or may not call themselves creationists is the argument for "intelligent design."[120]

In day-to-day application, of course, only tiny portions of the universe are considered liable to this supernatural way of doing things. The belief in miracles, for instance, is an attempt to make the idea of ***creation*** a living reality rather than a remote suspicion. Even where the belief in gods and miracles is in decline, more sophisticated forms of creationism arise to take its place.[121] For example, in the United States up to 90 percent of the citizens[122] and over half of the scientists believe in extrasensory perception (ESP)[123] even though there isn't a shred of scientific evidence for it.[124]

All manner of occult beliefs remain ever popular even though they have repeatedly failed the simplest of scientific tests. Psychics,[125] astrologers,[126] psychic healers,[127] and the prayerful[128] actually have taken a good drubbing in the popular press, but the ignorance keeps on coming with the birth of each child. For the most part, such stories are overlooked on the way to the astrological charts that serve as daily fare. If anything, the prevalence of occult belief, and especially its new-age adoption in the form of eastern mysticism within the very heart of modern physics,[129] shows ***creation*** to be a viable alternative to *conservation*.

From Atomism to Evolution

The idea of conservation evolved out of the primitive idea of matter. The atomists assumed that matter consists of hard little balls composed of an indivisible material. It was these bits of matter, then, that were conserved. They had a stability or permanence transcending that of the objects of which they were parts. In the extreme, these atoms were considered indestructible and eternal. As recently at the eighteenth century, this simple belief in the conservation of matter successfully guided great scientific achievements.

For example, Antoine Lavoisier, often called the father of modern chemistry, noted that certain materials gained weight when ignited. He assumed that this added weight was a result of added matter that existed prior to combustion. While a creationist might have insisted that the increase in weight was indeed a miracle—that something had been created out of nothing—Lavoisier looked to the atmosphere for the missing constituent: oxygen. Lavoisier then showed that certain elements always combined with certain other elements in fixed ratios. For instance, twelve grams of carbon combined with thirty-two grams of oxygen to form forty-four grams of carbon dioxide. For a long time, conservation, conceived exclusively as the conservation of matter, achieved success after success.

At first, when it was noticed that every chemical reaction either emitted or absorbed heat, it was logical to assume that the heat was just another form of matter: the caloric fluid. The caloric theory was a simple extension of the assumption that matter is always conserved.

What was missing from the law of conservation, of course, was the same concept that was missing from materialism prior to *inseparability*: motion. Here again we see the lag in the development of the idea of motion. Because motion was not a thing, its conservation could not be viewed in the same, simple way that an atomist could view the conservation of matter. The idea of its conservation could not arise until Newtonian dynamics began to show how.

Once heat was viewed as motion rather than matter, there was no denying the inclusion of all other forms of motion within the framework of *conservation*. Today, conservation is usually stated as the First Law of Thermodynamics, otherwise known as the law of the conservation of energy: "Energy may be transformed from one form to another, but it cannot be created or destroyed, and the total energy of an isolated system is constant."[130] Although energy is a matter-motion term, one suspects that it is motion instead of matter that now has gotten the upper hand in this modern statement of conservation. That is why I prefer to state *conservation* in a way that is clearly compatible with *inseparability*: *matter and the motion of matter neither can be created nor destroyed*. The following reaction illustrates the practical use of this conception of *conservation*. Methane gas burns in the presence of oxygen with the production of carbon dioxide and water and the emission of heat:

$$CH_4 + 2O_2 + \text{kcal} \longrightarrow CO_2 + 2H_2O + 212\ \text{kcal} \qquad (3\text{-}2)$$

methane	oxygen	activating motion	carbon dioxide	water	heat motion

Note that the number of carbon [C], oxygen [O], and hydrogen [H] atoms before and after the reaction is the same. All that happens during the reaction is the conversion of one form of matter in motion into another form of matter in motion. Hydrogen diverges from its combination with carbon in methane to converge on and combine with oxygen as water. Some of the oxygen also converges on carbon to form carbon dioxide. Some of the rapid vibrations of methane and oxygen molecules have been converted into the slower vibrations of carbon dioxide and water and the faster motions of whatever matter exists in the surroundings.

From equation 3-2 it should be clear that what is being conserved is both matter and motion. One type of matter in motion is being changed into another type of matter in motion; one type of the motion of matter is being changed into another type of the motion of matter. The conventional use of the matter-motion term *energy* to describe conservation might be admirable, if it did not end up being philosophically misleading.

Challenges to Conservation

As with the other assumptions of science, *conservation* has met many challenges from the opposing viewpoint. For obvious reasons, it is seldom admitted that *conservation* implies that the universe is eternal. Still, whoever uses this assumption invariably conflicts at some point with those who hypothesize a "first cause" for the universe. The *creation* argument is indeterministic, not only because the so-called causative agent that it assumes is immaterial, but also because it assumes that something can be created out of nothing. This agent is therefore empty, vacuous, without integrity, and without the possibility of existence. Creationists seldom agree on where in the causal chain of natural events this supernatural activity should be inserted. Some insist that *creation* is occurring at this very moment, while others insist it occurred 13.7 billion years ago. Except for its temporary suspension in conventional cosmology, however, *conservation* has met the challenge and succeeded in pushing *creation* from serious scientific discourse. This is especially true now that the concept of motion has survived the nineteenth-century firestorm engendered by its inclusion in the law of conservation.

Geology

Some of the earliest battles over *conservation* took place in the study of geology, where field evidence indicated that the Earth was much older than biblical accounts of ***creation*** would have it.[131] *Conservation* entered the debate in the form of *uniformitarianism*, the assumption that geological processes occurred in the past at the same rate as at present. To squeeze their interpretations into the six thousand years then allowed by church doctrine, devout geologists invented an opposing assumption: *catastrophism*, the view that geological processes were much more rapid in the past than at present. With catastrophism, sedimentary sections hundreds of meters thick still could be attributed to the biblical flood.

Although it is true that some geological processes are indeed extremely rapid, this did not explain the fossil evidence. Fossils collected from the upper portions of sedimentary sections were more like those of today than the ones from the lower portions. Many species had changed noticeably during the deposition period. Forty days and forty nights didn't come close. Some creationists figured that these changes were brought about by individual miracle and could still fit the time frame of the deluge. Still others saw the progression of the fossils as the result of acts of the devil meant only to confuse the weak of faith. This new version of *conservation* brought the conflict closer and closer to biology, preparing the way for Darwin. In 1841, Hugh Miller pointed out the terrible choice that confronted would-be scientists: "There is no progression. If fish rose into reptiles, it must have been by sudden transformation … There is no getting rid of miracle in the case—there is no alternative between creation and metamorphoses. The infidel substitutes progression for Deity; Geology robs him of his god."[132]

Biology

In biology, uniformitarianism found its parallel in the doctrine of evolution. Throughout science the belief in the conservation of *things* evolved into the belief in the conservation of *processes*. The full implication was that nothing was immutable; absolutely everything was in motion, evolving into other things. Whereas some past notions of conservation might have been supportive of ***creation***, this no longer remained the case.

The revolution was marked by the publication of Charles Darwin's classic in 1859 that unleashed the greatest of all battles between science and religion.[133] Won overtly by religion and covertly by science, the evolution-***creation*** struggle continues to this day. As recently as the Scopes Monkey Trial of 1927, creationists were successful at preventing the explicit teaching of evolution in science courses, at least at the elementary levels. Of course, for scientific research to advance at all, some form of conservation doctrine was an absolute necessity—like Lavoisier, one could scarcely do a chemistry experiment without it. Indeterministic control generally has been weak at the college level, where the teaching of evolution has frequently provided a revelation for those who were only warned of its vices while in high school.[134] Today the concept of evolution is occasionally taught in the lower grades as part of the science curriculum, where it is free to confront creationists at an early age. In the United States, evolutionary ideas are no longer restricted to the college educated, except in the most backward of communities.

Nonetheless, skirmishes between evolutionists and creationists have been especially hot topics in the United States during the last two decades,[135] reaffirming the undying opposition between the assumptions of *conservation* and ***creation***.

Because scientific advancement without the concept of evolution is no longer possible, these debates now serve mostly as opportunities for educating the public and irritating the clergy.

Cosmology

In cosmology, theories of the origin of the solar system went through a similar evolution.[136] Newton, in keeping with his religious and atomistic views, believed that the immutable objects of the solar system were set into motion by the "force" of the creator. As late as 1781, even the irreligious French naturalist Comte de Buffon supported ***creation*** as the logical origin of the solar system. In the nineteenth century, Laplace, following Immanuel Kant, proposed the nebular hypothesis for its origin. At first this threatened a science-religion conflict almost as vehement as the one in biology,[137] but the idea that the sun and planets accreted from a nebular cloud readily invoked images like those in biblical accounts. As always, natural order also could be viewed as the handiwork of an omniscient creator. Within every conflict lies the possibility of peaceful settlement; "The potential threat to scientific progress posed by the insistence on agreement between science and the Bible failed to materialize largely because pious and ingenious men repeatedly succeeded in devising new ways to reconcile the two revelations."[138] In this endeavor astrophysics currently leads the way,[139] but not without resistance.[140]

The lesson is clear: no matter what deterministic scheme is proposed, it can always be diluted to make its implications more palatable to the indeterminist.

The assumption of *creation* may have been pushed out of the solar system, and studies of galactic evolution[141] may have pushed it still further, but it has not been removed from scientific thought altogether. We find that scientifically credible theories of the universe still may be classified either as *cosmologies*, which, in keeping with *conservation*, assume that the universe had no origin, or as *cosmogonies*, which, in keeping with *creation*, assume that it did. Despite the special pleas that can be made for it,[142] today's most popular theory, the standard Big Bang, is of the second type. As you will note throughout this discussion, the Big Bang Theory is a blatant violation of many other scientific assumptions in addition to *conservation*.

From the Static to the Dynamic

The struggle to include motion in the law of conservation mirrored the development of *inseparability*. Just as *materialism* had to be supplemented with *causality* to advance from materialism to determinism, the concept of matter had to be united with the concept of motion in the assumption of *conservation*. The static materialistic worldview thereby gave way to a dynamic materialistic worldview. As an indeterministic alternative, ***creation*** remains as useless as it ever was for guiding scientific investigation. The hypothesis of an immaterial "first cause" for any particular phenomenon really is not a beginning point, but an ending point.

The Sixth Assumption of Science: Complementarity

All bodies are subject to divergence and convergence from other bodies.

With *inseparability*, and again with *conservation*, the external world was viewed as matter in motion. *Complementarity* continues with this point of view, interpreting the Second Law of Thermodynamics (SLT) as a law of divergence and its so-far unrecognized complement as a law of convergence. Only by assuming *complementarity* can we resolve the contradiction between *conservation*, which assumes that the universe is eternal, and the indeterministic interpretation of the SLT, which implies that it is not.

The alternative, ***noncomplementarity***, assumes that matter or motion (by itself) can diverge from one part of the universe without converging on another part. It hypothesizes an ever-increasing disorder in the universe, but cannot adequately explain the increases in order we see all around us. This last difficulty, peculiar to today's system-oriented view, I call the "SLT-Order Paradox." Through its resolution the idea behind *complementarity* will become clear.

The SLT-Order Paradox

The Second Law of Thermodynamics (SLT) states that *the entropy or apparent disorder of an ideally isolated system can only increase*. In the strictest sense, the SLT says everything about increasing disorder, but nothing about increasing order. Yet as philosopher-physicist L. L. Whyte noted, "The fact which we cannot, it seems, deny is that over vast regions of space and immense periods of time the tendency toward disorder has not been powerful enough to arrest the formation of the great inorganic hierarchy and the myriad organic ones."[143]

Indeed, one only needs to look around to see that for every system in which order is decreasing, there is another in which order is increasing. The SLT, however, predicts only destruction, while nature exhibits construction as well—the SLT-Order Paradox. The Second Law of Thermodynamics obviously tells only half of the story.

The other half of the story is still to be explained by a principle that complements the SLT. Many investigators[144] have recognized that the SLT by itself is inadequate for resolving the SLT-Order Paradox and for explaining the source of order. They obviously have not been completely satisfied with the conventional resolution of the paradox, which is generally stated like this: "Whenever a semblance of order is created anywhere on Earth or in the universe, it is done at the expense of causing an even greater disorder in the surrounding environment."[145]

Of course, this implies that a finite, isolated universe would run down like a clock. In the popularized view, the universe is descending deeper and deeper into chaos as the order in the surroundings of every system is exhausted.[146] This prospect causes philosophical unease among scientists because it implies an initial ***creation*** as well as an eventual "heat death" of the universe. We require some principle that would both complement the SLT and avoid this predicted violation of *conservation*, the assumption that matter and the motion of matter neither can be created nor destroyed. There are no scientifically verified exceptions to either the First or the Second Law of Thermodynamics. And yet, there is still no adequate explanation for the apparent production of order from disorder.

Clearly, to resolve the SLT-Order Paradox we must have a radical departure from the present theoretical approach to the problem rather than a change in experimental technique or calculation. If the ending predicted by the current interpretation of the SLT is unacceptable, then there must be something wrong with its initial assumptions.

At this point it may be helpful to explain briefly what scientists mean when they speak of an "isolated system," "controlling an experiment," or "closing the doors" on a portion of the universe. In conventional scientific terminology, the closest thing to "a portion of the universe" is called a *system*, any object or group of objects that the investigator wishes to consider and to delineate in some way.[147] Ideally, systems can be of three types: isolated, closed, or open. *Isolated* systems exchange neither matter nor motion with the environment. *Closed* systems exchange motion but not matter. *Open* systems exchange both matter and motion. These definitions are idealizations developed from the study of relatively isolated and relatively closed systems. In reality, all systems are open systems; truly isolated or truly closed systems cannot exist.

Although competent scientists no longer believe that any real system could be ideally isolated, few of them seem prepared for the next step: the concept of ideal nonisolation. *Complementarity* assumes that, in an infinite universe, all real systems exist between the extremes of ideal isolation and ideal nonisolation. Whereas a high degree of isolation implies minimum contact between the system and its environment, a high degree of nonisolation implies maximum contact between the system and its environment.

Science has traditionally emphasized one end of this continuum: the system, isolation, increasing disorder, and the SLT. We need to emphasize the other end too: the environment, nonisolation, increasing order, and the complement of the SLT. The resolution of the SLT-Order Paradox awaits a balanced consideration of both the system and its environment. If this analysis is correct, then traditional, system-oriented attempts at resolution are bound to fail, as a few notable examples will demonstrate.

System-Oriented Rationalizations of the Paradox

Each system-oriented attempt to resolve the paradox fails to the degree that it favors the system over the environment. Note in each of the examples that whether the proposal involves unabashed vitalism,[148] the "geometry of space-time,"[149] outright contradiction,[150] or sophisticated neovitalism,[151] the key to the production of order, the environment, is slighted.

Schroedinger (1967)

In addition to his work on wave equations in quantum mechanics, Erwin Schroedinger is known for his popularization of the concept of "negative entropy" or negentropy as a resolution of the SLT-Order Paradox.[152] In itself, the idea of an ordering process that functions as the dialectical opposite of the disordering process is excellent. The term *negentropy* is likewise excellent. What must be objected to is the biased way that Schroedinger described the negentropic process.

Negentropy was seen as a "fight" in which organisms, by themselves, overcame the havoc of the phenomena described by the SLT. The argument essentially followed the philosophical tradition of vitalism: neither matter nor the motion of matter was considered the initiator of the negentropic struggle. The mysterious source of order was internally derived, and was peculiar to living beings. Not only did Schroedinger overemphasize the system itself as a source of order, but he left the SLT-Order Paradox unresolved, at least wherever life was not evident.

Whyte (1974)

A slightly improved attempt to resolve the apparent contradiction between the SLT and the tendency toward increases in order was made by L. L. Whyte.[153] Unlike Schroedinger, Whyte was careful to include the inorganic as well as the organic realm in his suggestion. Like Schroedinger, Whyte recognized the need for *complementarity* when he wrote of the "two great, and *apparently* opposed, general tendencies."[154] Unlike Schroedinger, Whyte did not overtly confine his search for the source of increasing order to the system itself. Instead, he tried to avoid consideration of system-environment interactions through an approach that was more in tune with modern physics than with systems analysis.

Whyte's suggestion is puzzling. The first of the opposed tendencies involved matter and was "TOWARD DYNAMICAL DISORDER called *Entropic*."[155] The second involved geometry and was "TOWARD SPATIAL ORDER called Morphic."[156] Just how matter and geometry can be seen as independent features of the universe was not explained. As far as I can tell, the "Morphic" tendency seems to have much in common with "curved space" in the general theory of relativity. It explains the tendency toward order in one of the ways Einstein explained gravitation. The "geometry of space" purportedly supplies the orderly, passive fabric upon which the SLT operates, somewhat like the "celestial sphere" of pre-Copernican times. Whyte's answer to the SLT-Order Paradox requires the inscrutable interaction of matter with the supposed four-dimensional geometry of "spacetime" rather than the interaction of matter with matter.

Makridakis (1977)

Spyros Makridakis, a management scientist specializing in General Systems Theory, took his shot at the paradox by rightly claiming that the exact opposite of the SLT was as natural as the SLT itself.[157] But then he proceeded to get it backwards. According to Makridakis, the Second Law of Systems resolved the SLT-Order Paradox on its own; "things tend to become more orderly if they are left to themselves." The phrase "left to themselves" normally means that there is no outside interference. Of course, any system not subject to any outside interference whatsoever is an ideally isolated system. Rather than being a complement to the SLT, this suggestion was merely a contradiction of it. The opposition between the SLT and its complement cannot be derived by viewing systems in their isolation, but in their nonisolation. With respect to the SLT, Makridakis carried systems philosophy to its logical conclusion. The only thing that would save the Second Law of Systems would be to change it to read: "things become more orderly if they are *not* left to themselves."

Prigogine (1978)

Perhaps the most celebrated approach to the SLT-Order Paradox within the discipline of thermodynamics was developed by Nobelist Ilya Prigogine.[158] While Schroedinger and, again, Makridakis unabashedly treated systems in the customary way (as isolated entities providing their own source of order), Prigogine took some of the early steps toward viewing the environment rather than the system as a source of order.

Prigogine's challenge to classical thermodynamics suitably stressed that complex structures can exist only through continuous interaction with their surroundings. Without this interaction, structures tend to "dissipate." That is, they lose matter or motion per the SLT. Following Onsager,[159] Prigogine developed the principle of minimum entropy production. His most important conclusion: there had to be a relationship between the production of order and the prevention of disorder.

Unfortunately, due to the constraints of the paradigm—systems philosophy—under which Prigogine and almost all modern scientists work, this did not lead directly to a singular principle that could be considered fully complementary to the SLT. Prigogine eventually was led to suggest some silly producers of order: fluctuations, distance from equilibrium, and nonlinearity that were not explicitly system-environment interactions. In the end, they had to be considered subsystem interactions.

Despite all his mathematical acrobatics, Prigogine's mechanisms could not be considered net producers of order for the system as a whole in the same way that phenomena described by the SLT produce disorder for the system as a whole. Thus, fluctuations produced as a result of interactions between the system and its environment eventually ended up being attributed to the system itself. Similarly, equilibrium and nonlinearity were said to occur *in* the system rather than *between* the system and its environment. There was always a residual bias in favor of the system over the environment.

Like Schroedinger, Whyte, and Makridakis, Prigogine offered reasons for the production of order in opposition to the SLT from a system-oriented point of view. Following tradition, he ultimately focused on the system—the forte of the SLT—to the neglect of the environment. He insisted that the production of order is a "self-organizing" process—a sort of neovitalism that, although not restricted to living systems, ultimately neglects environmental factors as producers of order. In my view, the ideal of nonisolation is equally as important as the ideal of isolation. Because such belief is, by definition, foreign to systems philosophy, it cannot produce a complement to the Second Law of Thermodynamics.

Resolution of the Paradox

Systems philosophy was adequate for developing the SLT, a law about ideal isolation. An environmentally focused viewpoint would permit the development of a complementary principle, a law about ideal nonisolation. The unification of these two one-sided viewpoints must consider both systems and their environments as equally important. *The SLT-Order Paradox can be resolved only through a* *balanced system-environment approach that describes the reality existing between ideal isolation and ideal nonisolation.*

Actually, an early step in this direction had been taken long ago by classical mechanics. According to Newton's First Law of Motion, "Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon."[160] Like those who later developed thermodynamics, Newton first assumed that his system was ideally isolated. Newtonian bodies traveled through "empty space" or the "stationary ether" under their own inertia. Then, on second thought, he discarded the notion of ideal isolation and completed his First Law of Motion. Classical thermodynamics managed the first thought but not the second.

In devising the SLT, the originators of thermodynamics also assumed the system to be ideally isolated—it was necessary to be temporarily myopic. But if we should now reject this system myopia as Newton attempted to do, we would have a pertinent question to ask: "If matter or the motion of matter has diverged spontaneously from such an 'isolated system,' where has it gone?" The obvious answer is that it has moved toward other matter in the universe. If the universe were infinite, there would be no perfectly isolated systems; all matter everywhere would converge on and diverge from matter everywhere else.

If the above statement is true, then Newton's First Law of Motion must be modified to recognize this balance explicitly—the word *unless* must be replaced by the word *until*. This small adjustment completes the train of thought that Newton only began and classical thermodynamics never really started. Indeed, matter in motion is inconceivable without the ideas of departure and arrival. The SLT is a law of divergence. It is like a travel schedule showing only departures. Its complement is a law of convergence. It is like a travel schedule showing only arrivals. Together, the SLT and its complement quite simply describe the motion of matter.

This modification of classical mechanics is consistent with the fundamentals of thermodynamics. For example, in the usual demonstration of the SLT (Fig. 3-3), chamber A is filled with gas and chamber B is essentially a vacuum. Opening the valve between the two (considered a "negligible" outside influence) allows gas from chamber A to enter chamber B spontaneously and irreversibly. This "spontaneity" is merely a reflection of the inertial motion of the gas molecules that, instead of colliding with the valve, now move through it. Entropy (or apparent disorder) increases as the molecules of the gas diverge from each other as they emerge from chamber A. The process is irreversible because all the gas molecules will not spontaneously return to chamber A by themselves. They cannot be "self-organizing" despite Prigogine's special pleas. To produce a vacuum at chamber B and reestablish the previously "better-ordered" state, we would have to introduce some extremely significant outside influence clearly forbidden by the assumption that this is an isolated system. The strength of the classical view, not countermanded by Prigogine or anyone else, is its insistence that an ideally isolated system cannot, of itself, produce a net increase in order. *The source of the order-producing mechanism must lie outside the system itself.*

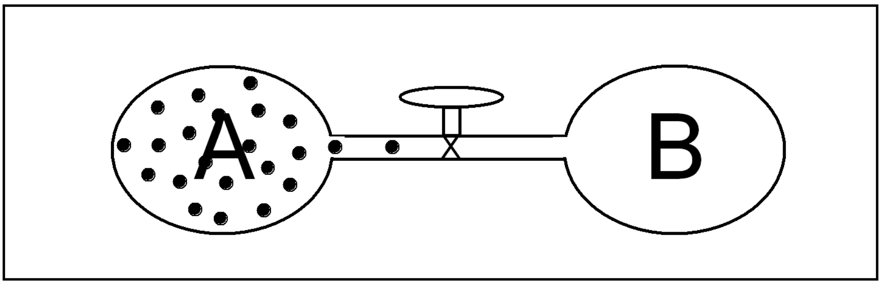


Fig. 3-3. The classical demonstration of entropy change described by the Second Law of Thermodynamics. An increase in entropy is produced when the gas in chamber A is allowed to pass through the valve into the vacuum of chamber B.

In this demonstration, the usual focus is on the divergence from chamber A, but if we view it from the perspective of chamber B, we see convergence instead. The gas molecules from chamber A rush in upon chamber B just as spontaneously and just as irreversibly as they left chamber A. If disorder has been produced in chamber A, order has been produced in chamber B. In an infinite universe, an increase in entropy in one place results in a simultaneous and equivalent decrease in entropy in another. The convergence of material entities results in an apparent increase in order or organization—the phenomenon that the SLT, by itself, cannot explain.

Subjectivity of Order-Disorder

Until this point I have used *entropy* and *disorder* as fully interchangeable terms in line with the present convention. But entropy and disorder were not always considered interchangeable. When Rudolf Clausius introduced the term *entropy* more than a century ago, it was unclear what meaning, if any, could be assigned to it. At most, entropy simply meant "transformation."[161] Its association with disorder seems to have grown along with the acceptance of the Copenhagen interpretation of the Heisenberg Uncertainty Principle. Any objection to making entropy and disorder equivalent unavoidably must have a distinctive anti-Copenhagen flavor. For example, in information theory Claude Shannon drew his share of indeterministic criticism for considering entropy as the degree of ignorance about a system.[162] Entropy-ignorance-disorder—the implications of such a linkage are clear. The inclusion of an obviously subjective condition in the series forces us into another look at the nature of the order-disorder concept.

Ordinarily there is little dispute that the classical demonstration of the SLT (Fig. 3-3) illustrates the production of disorder. But what can be said about changes in order when we modify the context of the demonstration as shown in Fig. 3-4? When the valve is opened, one can just as easily conclude that the system containing the eighteen gas chambers becomes more orderly, not less so. Changes in entropy reflect objective changes in divergence or convergence, while order-disorder is purely subjective.

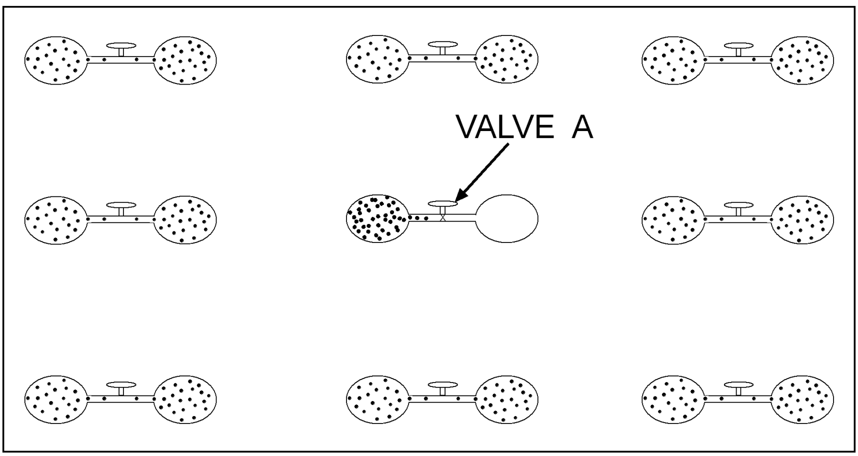


Fig. 3-4. Demonstration of the subjectivity of the order-disorder concept. Does turning valve A result in an increase or does it result in a decrease in order?

As much as this may upset our private feelings of order and disorder, it is nonetheless consistent with determinism, which considers the universe to be orderly, not disorderly: law-like, not lawless. The upshot is that the SLT and its complement must describe something more than mere subjective changes in order.

Objectivity of Divergence-Convergence

As I pointed out before, the foremost assumption of mechanics is that the infinite universe consists only of matter in motion.

In mechanical terms, the SLT would be:

All bodies are subject to divergence from other bodies.

Its mechanical complement proposed here becomes:

All bodies are subject to convergence from other bodies.

The SLT-Order Paradox is resolved only by uniting thermodynamics with mechanics. In the process, the order-disorder concept necessarily loses objective meaning. Entropy becomes a statement about divergence, and its opposite, negentropy, becomes a statement about convergence. Subjectively, we can still view increasing disorder as things "fall apart" and increasing order as things "come together." Because the motions of matter are relative, the motion of a particular object may be a divergence for an observer at one point, while it may be a convergence for an observer at another point. Divergence and convergence are the essence of the motion of matter and must be considered objective and necessary features of the infinite universe.

The possibility of nearly ideal isolation derives from the possibility of divergence; the possibility of nearly ideal nonisolation derives from the possibility of convergence. In thermodynamic terms, the complement to the SLT becomes: *the entropy or apparent disorder of an ideally nonisolated system can only decrease*. No object can be completely isolated, just as no object can be in an all-encompassing contact with its surroundings. Ideal isolation and ideal nonisolation are opposite ends of the continuum we use to describe the relationships between real objects and their surroundings.

With respect to each other, any two objects are semi-isolated to the degree of their separation and semi-nonisolated to the degree of their union. What we observe as increases in entropy for a particular system are results of the divergence of matter or the motion of matter from that system. What we observe as decreases in entropy for a particular system are results of the convergence of matter or the motion of matter upon that system. Isolation and nonisolation, therefore, are complementary aspects of the motion of matter.

The Dialectics of Matter in Motion

Because all matter in the universe is in constant motion, it is continually moving across or transmitting motion across system-environment boundaries. The entropy or state of divergence of a particular portion of the universe is always either increasing or decreasing. The SLT is a law of departure; its complement is a law of arrival. Ironically, the very ideal we required for formulating the SLT, perfect isolation, would prevent its operation. For the entropy of a system to increase, parts of that system must be able to interact with its environment.

To the degree that the system cannot transmit motion to the environment, it tends to expand; that is, it invades a portion of the universe formerly classified as "environment." Cosmogonists have applied this necessity for system expansion to the universe itself, but this is a *non sequitur*. The only requirement is for there to be an environment for the parts of a system to move into or to transfer motion to. An infinite universe in which matter and the motion of matter is not everywhere the same is sufficient.

The irreversibility to which the SLT and its complement speak is not a result of a grand, universal predominance of divergence over convergence, but simply a result of the motion of matter within an infinite universe. All systems, being in continual motion relative to each other, have a unique relation to all other systems in the universe at any moment. The motion of a system as a whole relates only to its surroundings. We must view the apparent production, maintenance, and destruction of order, not as a property of the system, but as a relationship between system and environment.

The question arises as to the experimental relevance of this mechanical complement to the SLT. We will continue to study the interactions of subsystems in which entropy (or disorder, from the subjective point of view) is produced and destroyed as subsystems diverge and converge. Nevertheless, because subsystems are always parts of larger systems and these are parts of still larger systems, we must expect eventual convergence from systems unfamiliar to us. The complement to the SLT, convergence, ultimately must be a law of the unknown—a law that predicts that no matter how much we widen the boundaries of a system, there will always be matter in motion outside that system.

The philosophical shift from the system-oriented approach to the system-environment approach resolves the SLT-Order Paradox. The acceptance of *complementarity* for the Second Law of Thermodynamics requires an acceptance of the other assumptions of science. **Noncomplementarity**, the indeterministic alternative, can exist only in a finite universe in which the system is considered more important than its environment. The rejection of this "system myopia" will be the culmination of the great work that Copernicus began.[163]

The Seventh Assumption of Science: Irreversibility

All processes are irreversible.

We are continually reminded—often sadly—of significant features of our lives that are unmistakably irreversible: we lose teeth, hair, and other body parts.

Friends grow old and die. Instinctively we know that there is no traveling back in time, although we may dream of it and try to recreate the conditions of a former happy period.

We feel the passage of time described by the Seventh Assumption of Science, *irreversibility*. And what *is* time? Does time occur independently of matter? Is it a property of matter? Is it another dimension of matter? Is it a concept? Is it a measurement? Or is it, as Santayana said, just "another name for the native instability of matter"?[164]

Time is a perennial subject of philosophical contention. In this debate it is the special mission of indeterminists to portray time as an unfathomable mystery, while it is the business of determinists to portray time as inseparable from matter.[165] As we were encouraged to do under inseparability, the first step in the analysis of any phenomenon is to determine whether that phenomenon is matter or whether it is the motion of matter. Even to the naïve observer, time is clearly not matter. It certainly does not exist in the way that matter exists. Although we may speak of finding a "chunk of time" to carry out one of our special projects, only a fool would search for it in a literal sense. Time does not "exist," it "occurs."

Next we must distinguish between time and the concept of time. The problem is similar to that discussed under *materialism*. Matter, we assumed, exists external to us. Similarly, time occurs external to us. The concept of matter was an abstraction we used when referring to "all things." We assumed that matter per se does not exist, that only particular examples of matter exist. Likewise, the concept of time is an abstraction we use when referring to "all events." Strictly speaking, time per se does not occur; only particular events occur. As with the existence of matter, time occurs independently of us regardless of what we are able to say about it.

In practice, the concept of time encourages the attempt to relate the motions of one thing to the motions of other things. Time is thus an echo of *causality*. The concept of time teaches us to relate the specific to the general, to view a system in its relation to the rest of the universe. The belief in *irreversibility* requires an acknowledgment of the importance of the environment, while its indeterministic alternative, **reversibility**, habitually denies it.[166]

In asserting that some processes are reversible, indeterminists reflect not only the narrow perspective of systems philosophy, but also the dreams of political reactionaries who seek to "turn back the hands of time." Some form of the belief in **reversibility** seems likely to remain with us indefinitely even though it becomes more and more untenable each day. Planck was right in pointing out that the antithesis between *irreversibility* and **reversibility** that he thought irresolvable would play a leading role in the development of the scientific worldview.[167]

History of Irreversibility

A feeling for *irreversibility* develops in anyone who has ever watched a birth, a death, a beginning, or an ending. It is a basic theme of poetry, art, and philosophy. In science, though, it did not receive its greatest impetus until the antiquity of the universe first became apparent.[168] According to Stephen Toulmin, "This 'discovery of time' has taken place almost entirely since AD 1800, and the mid-nineteenth century debates about evolution were only one small but particularly noisy episode in a much larger intellectual revolution."[169]

Laplace is typical of the many scientists who "discovered time" in the course of their work. He had spent the first quarter of the century trying to prove that the solar system is eternally stable, that it has always existed. But then, almost as an afterthought, he included a footnote in which he demolished his main point by proposing an origin for the solar system. From thenceforth the development of the solar system was to be seen as irreversible.

In geology too, the same conservative instincts were at work when Hutton popularized the uniformitarian principle.[170] Uniformitarianism declared that the same motions were repeated over and over again. The past was the perfect key to the future. Taken literally and absolutely, uniformitarianism, like Laplacian determinism, was just another version of finite universal causality. There could be no progression. Of course, the fossil evidence noted by Cuvier in 1810 belied this. Used at first in support of uniformitarianism (defined at that time as slow natural change) in the battle against catastrophism (defined at that time as rapid supernatural change), fossil progression implied that the past was a less than perfect key to the future. The unprecedented elements in the historical record signaled the beginning of the end for finite universal causality and **reversibility**.

In biology[171] and sociology,[172] *irreversibility* also made huge inroads. But it was chemistry that came closest to establishing it as a fundamental law of the universe. As we have already seen, the rejection of the caloric theory in the 1840's forced the concept of motion to be included along with the concept of matter in the assumption of *conservation* (First Law of Thermodynamics). Further development in this new subdiscipline of chemistry could no longer avoid *irreversibility*. The Second Law of Thermodynamics (SLT) became, in effect, the discovery of chemical evolution.[173] And as Lewis and Randall pointed out, the SLT encountered considerably more philosophical resistance than the First Law of Thermodynamics.[174] As long as the First Law was interpreted only as a statement about the conservation of matter, it could be construed as being compatible with ***creation*** (i.e., once created, matter would stay created). The idea of supernaturally created matter accorded with the idea of naturally unchanging matter. Religious-atomistic views were threatened as soon as matter was discovered to be naturally changing and without the permanence assumed by ***certainty*** and ***separability***.

As the static view gradually gave way to the dynamic, believers in **reversibility** developed a settlement that acknowledged the occurrence of motion, but only in an offhand way. Grudgingly, they admitted that the motions of things within isolated systems went forward, but were quick to point out that they went "backward," too. For idealists, the perfect repetition of the internal motions of the isolated system could produce perfect equilibrium—a new kind of perfect rest. Such a system, displaying no real change over time, was, like the perfectly solid matter of the atomist, a bulwark against the idea of evolution.

It is ironic that the fundamentally conservative idea of isolation conspired against its masters in the development of the SLT. At first, systems supposed to be free from outside interference were viewed as possessing cyclic inner motions capable of continuing indefinitely. Such systems would be "perpetual motion machines," and since they never exchanged matter or motion with their surroundings, they would exist forever in their originally "created" forms. This vision was soon found to be hopelessly unrealistic. Even those systems coming closest to being perfectly isolated were only approximately so. Every system-environment interface anyone could design was "leaky." Matter invariably got through the "holes" in the containers or transmitted some of its motion through the walls. Worst of all, without continuous contact with an environment identical to the one that produced it, every system underwent an irreversible dissipation.

As already mentioned under *complementarity*, the systems interpretation of the SLT foretold a strange kind of "progress." It was one in which things tended to fall apart rather than come together. It spoke of increasing destruction and disorder rather than increasing construction and order. Without its complement, interpretations of the SLT were invariably pessimistic and regressive. Such views were very much a reaction to the trials and tribulations of the Industrial Revolution.[175] Even so, with the SLT, systems philosophy had destroyed forever the myths of permanency and **reversibility**. It did not require an acceptance of progress to do it.

How Complementarity Implies Irreversibility

Even without its complement, the SLT gave modest support to *irreversibility*. Certain leaders in classical thermodynamics, realizing that perfect isolation was only a fiction, were aptly dogmatic; "any actual process is said to be *irreversible*."[176] No matter what the system, the SLT correctly predicted that eventually it would lose matter and motion and that it would not, by itself, be able to restore that matter and motion. There was no doubt that without **reversibility** the universe could not be both eternal and finite.[177]

As explained under *complementarity*, each portion of the infinite universe is in motion with respect to all the other portions. The departure of matter and motion from one part of the universe always implies an arrival of that matter and motion at another part of the universe. In such a universe, divergence is equivalent to convergence. The SLT becomes a law of divergence and its complement becomes a law of convergence.

That would not be true for a finite universe. In a finite system, say the pieces of a chess set confined to a table top, one can consider the equivalence of divergence and convergence instead as a support for **reversibility**. Any of the chess pieces can be moved around the board and then returned to its previous position. By sticking closely to systems philosophy, even the convergence produced by the hand that moves the piece could be viewed either as insignificant or as perpetually repeatable. Any finite number of items and any finite portion of the universe would produce the same result: a finite number of combinations. Such a finite system does not evolve because nothing new is allowed to enter it. It can only repeat itself, endlessly producing and destroying the same limited patterns.

So *irreversibility* cannot be justified from a strictly system-oriented point of view. The SLT was successful only because, ever so slightly, it was forced to admit the existence of the environment. Without this "dumping ground" for the matter and motion that left it, the system would have been everlasting and the phenomena described by the SLT could not occur. In an infinite universe of objects in continuous motion, the system-environment relationship of each object is continually changing. The parts of a system, such as the chess set, considered in isolation from the rest of the universe, may be placed in successive, identical relationships with each other. But as explained under *causality*, the relationship between any two objects is never independent of relations with still other objects, be they within the system or without. At the same moment that any two objects seem to be approaching a former relationship, other objects in the infinite universe are converging on them and diverging from them, ensuring that the relationships between the two objects and others outside the system are never identical at subsequent moments. Contrary to the indeterminist,[178] this does not negate causality—only the finite form of it. As Santayana so wisely put it, "All movements of matter are … responsive afresh to a total environment never exactly repeated, so that no single law would perfectly define all consecutive changes, … every response would be that of a newborn organism to an unprecedented world."[179]

Causality, *uncertainty*, and *irreversibility* thus are consupponible. In other words, if one assumes that all effects have an infinite number of causes, then it is also necessary to assume that an effect will never occur in exactly the same way twice. Not only are any causal laws we can devise finite and therefore incomplete, they also are derived from previously occurring causes. They cannot have all of the new elements that will contribute to a similar effect in the future.

The Myth of Reversibility

Reversibility remains a viable indeterministic alternative to *irreversibility*. But, just as few people admit to an outright belief in ***acausality***, few admit to an outright belief in **reversibility**. Nonetheless, **reversibility** often receives credence in specific instances. For example, it is not uncommon to find chemists and physicists who consider movements in opposite directions at equilibrium to be indications of **reversibility**. Even Max Planck believed that "the concept of entropy had a physical significance only where there could be a reversible process."[180] Viewed in a limited way—that is, from the point of view of systems philosophy—phenomena such as gravitation, mechanical and electrical oscillations, sound waves, and electromagnetic waves are commonly considered reversible in an absolute sense.[181] The correct interpretation, though, is that it is *irreversibility* that is absolute and **reversibility** that is not. The arrow of time points in only one direction.

Microscopic "Reversibility"

The challenge to *irreversibility* is, like ***acausality***, inserted into scientific discourse in subtle ways, if not inadvertently. It is worthwhile to discuss one such case. In *Geomorphology and Time*, Thornes and Brunsden were moved to write that "time is distinguished by possessing the property of intrinsic direction and in the *macroscopic* sense being irreversible [emphasis mine]."[182]

The implication, of course, is that **reversibility**, like ***acausality***, is probably rare, but might be possible in the microscopic realm. The argument for **reversibility** must be squeezed into the same small philosophical space occupied by the assumptions of ***certainty***, ***separability***, and ***acausality***. Primarily, it requires the estrangement of the concept of motion (i.e., time) from *causality*. It depends on the limitations of direct observation and on the necessity for probabilistic laws as a sort of grand *argumentum ad ignorantiam*.

As long as this kin of the Copenhagen viewpoint remains dominant, microscopic **reversibility** will have its overt defenders[183] and time cannot be viewed properly—as motion. Typically the confusion[184] is manifest at the point where systems philosophy breaks down: where the claims for ideal isolation obviously no longer fit the reality.[185] As subsystems approach equilibrium with each other, the relationship between the system and its environment becomes increasingly important. By continuing to ignore the environment as equilibrium develops, one must invent evermore overtly indeterministic interpretations of the phenomena under investigation.[186] At the extreme, the so-called reversible reactions near equilibrium have been thought to engender "cyclic time" which supposedly involves a sort of "time-canceling effect."[187]

Finally, in the words of our twentieth century indeterminists, "The situation in steady conditions is … time independent,"[188] and "The whole point of the analysis of measurement on the microscopic level (is) that there is nothing to abstract from."[189] This application of **reversibility** goes a long way in fulfilling the ancient desire of the indeterminist. To be independent of time would be for matter to be without motion, at absolute rest, isolated from the rest of the universe, independent from other matter in motion. The idea of time independence ultimately promises life eternal since it calls for matter to sit still and ultimately to disappear—the solipsist's dream.

Does Causality *Require Reversibility?*

To some, it may appear that without **reversibility**, perhaps even on a macroscopic scale, causality would be impossible. For successful prediction, wouldn't it seem that events must have some chance of recurring? In a previous passage Santayana eloquently expressed the uniqueness of every event, but here he takes an apparently opposed view: "Whatsoever spontaneously happens once will have spontaneously happened before and will spontaneously happen again, wherever similar events are in the same relation."[190]

The answer to this apparent contradiction appears in a single word: *similar*. All events are "similar" and not "identical," as would be required in an absolute conception of ***reversibility*** and the finite conception of causality against which I have argued. Only a conception of *causality* as infinite is in accord with *irreversibility* and the notion of "universal time," the feeling that every motion of every part of the universe is unique and never will be repeated.

If time is motion, as I have assumed, then according to *inseparability*, time cannot occur apart from matter. But as explained under *conservation*, it is a special preoccupation of certain indeterminists to try to imagine a "time" that occurred "prior" to the existence of the universe. Similarly, the hypothesis of microscopic **reversibility** rests on the ***separability*** of matter and motion—taken here as time independence. Although even modern physics teaches time dependency, this is in daily confrontation with indeterministic views advocating time independence. The clash represented by these opposed positions still remains too confusing and unnerving for those who are not quite sure and are all too quick to make the compromise between science and nonscience: "It is not the purpose of this book to perpetuate the rather fruitless polarization of the subject between … advocates of time dependency and time independency."[191]

Of course, the polarization is a reflection of the perpetual, progressive conflict between determinism and indeterminism. Only an indeterminist could regard the debate as fruitless. This typical, timorous approach, characteristic of Western attempts at scientific education, hardly can be conducive to efficient scientific development.

There is no time independence. This is first grade stuff and there is no point in being indecisive about it. Ever since Einstein's Special Theory of Relativity, the idea of time independence has been defunct. Remember, under *inseparability* we considered space as matter and time as motion. Even Minkowski hinted at this in his famous statement of 1908: "Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality."[192]

Irreversibility *and the Environment of the System*

In the deterministic view, absolutely no reaction or event "occurs" independent of time, because time is motion; the terms "reaction" and "event" are terms describing motion. No reaction or event is reversible in the absolute sense, because the material objects in the environment in which it takes place are in continuous motion. Each star, each galaxy, moves relative to all the others. The night sky is unique each time we view it. **Reversibility** could only occur in systems that are completely isolated from the rest of the universe. Such isolation is impossible and, therefore, **reversibility** is impossible. The Seventh Assumption of Science, *irreversibility*, asserts that **all** processes are irreversible. We need not delude ourselves into thinking that there are some exceptions involving ideal equilibrium or relative size.

The Eighth Assumption of Science: Infinity

> The universe is infinite, both in the microscopic and the macroscopic directions.

The universe is either infinite or finite. It is, of course, impossible to know for sure which of these possibilities really exists; we can only assume one or the other. Whenever someone claims to have found the edge of the universe, someone else is free to hypothesize objects beyond. Experience in particle physics and astronomy teaches us the utility of the Eighth Assumption of Science. And yet, each time a supposed limit is reached, the absence of data allows a choice between *infinity* and ***finity***, its opposite.

As I have mentioned, two very different scientific approaches have vied for the title of the "scientific worldview": classical mechanism and systems philosophy. Classical mechanism emphasized the external interactions of its model; systems philosophy emphasized the internal interactions of its model. In the evolution of the two points of view, the invention of the glass lens was both symbolic as well as instrumental. If the telescope was the tool of classical mechanism, the microscope was the tool of systems philosophy. The more one saw of the macroscopic world, the more one was impressed by its immensity; the more one saw of the microscopic world, the more one was impressed by its inexhaustibility. Unfortunately, the more one looks in one direction, the more one learns about that direction—and forgets about the other. Classical mechanism and systems philosophy developed two different views of infinity: macroscopic and microscopic.

Macroscopic Infinity and Classical Mechanism

Although philosophy contains numerous allusions to the possibility that the universe is infinite in both the macroscopic and microscopic directions, this always has been a heretical view. The macroscopic infinity proposed by Democritus and other atomists gave way during the Middle Ages to the practical demands of astronomy and religion. In tune with the widespread techniques developed in oceanic navigation, Ptolemaic cosmology invented the theory of the two-sphere universe in which the fixed sphere of the Earth was surrounded by a moving celestial sphere. This explained the obvious rotation of the night sky about the North Star and allowed for the fantastic heaven beyond. Thus when Giordano Bruno resurrected the theory of an infinite universe, he was, in effect, challenging the notion of an actual physical existence for paradise. This would not do. The reaction by the church was swift and terrible. Eschewing a Galilean-type recantation, Bruno was burned at the stake in 1600.

Nine years later, Galileo's telescopic observations accelerated an enumeration remarkable for its unceasing ability to furnish evidence for Bruno's speculation. With the telescope one could study the interactions of astronomical bodies. One need not be bothered particularly by questions concerning the constituents of those bodies. Thus, it was logical that Newton's later development of mechanics would pursue this obsession with the external as opposed to the internal. Like Bruno's less pious version of infinity, Newton's was macroscopic, not microscopic. Theirs was a vision of an infinite number of solid bodies in an infinite volume. But both retained the legacy of atomism, which, without a doubt, presumed microscopic finity.

Classical mechanism made its settlement with *infinity* in the traditional way: by neglecting, and thereby finalizing and finitizing, the insides of its model. Thus when Newtonian bodies collided, the irreversible effects on the internal motions of those bodies were not understood and had to be ignored. Newtonian bodies had permanence consistent with conservative, non-evolutionary views of society. Classical mechanism was a bitter pill, but it could be swallowed.

Microscopic Infinity and Systems Philosophy

For more than half a century, almost no one thought to turn Galileo's telescope around and look inward instead of outward. Then, in 1665, Robert Hooke's observations of the cellular structure of cork initiated a search, which, like Galileo's, has never failed to provide evidence for microscopic infinity. The pace of discovery in this direction, however, continued to lag behind that of the macroscopic. For instance, as early as 1683, Anton van Leeuwenhoek reported some casual observations of what only could have been bacteria, but these were not to be observed again for at least another century. A worldview that included microscopic infinity among its basic assumptions was to develop alongside classical mechanism, but it was to remain in the background until it could manufacture its own special compromise with *infinity*.

Indeterminism showed its great strength by disallowing the straightforward conclusion that the data from the telescope and the microscope warranted an assumption encompassing infinity in both directions. It was left to systems philosophy, actually present in one form or another ever since the evolution of the first ego, to develop the only choice possible under such circumstances. Ever adept at overemphasizing the internal as opposed to the external, systems philosophers gradually overcame the tremendous lead of the classical mechanists, who overemphasized the external as opposed to the internal. The prospects for microscopic infinity grew while those for macroscopic infinity withered.

Inevitably, the universe, too, again would be viewed from a system-oriented perspective. The whole universe, even though known to be billions of light years in extent, was to be viewed in isolation: a system without an environment. Twentieth century science admitted that systems evolved, but as I have explained under *complementarity*, it was reluctant to acknowledge the full impact of the environment. From the system-oriented point of view, the universe *had* to be finite. At the same time that science was leaning toward microscopic infinity, indeterminism was pressing for a return to macroscopic finity. Systems philosophy found the way.

To understand why systems philosophy was so successful in preparing the accommodation, we must recall the great theoretical revolution initiated by

Heisenberg. From Democritus to Laplace it was possible to advance the cause of determinism by assuming microscopic finity along with macroscopic infinity. But as we have seen, the Laplacian form of determinism is clearly unworkable. Its underlying assumption of ***finity*** is no longer compatible with the other Assumptions of Science. No longer could classical mechanism, based on this form of determinism, seriously propose that the ultimate constituents of matter eventually could be described in full. No longer was there any hope of realizing Einstein's dream of discovering the elementary laws by which the universe could be built up by simple deduction. According to *causality* and *uncertainty*, partial descriptions and fallible predictions are the only attainable reality.

As mentioned, through the Copenhagen interpretation, systems philosophy was able to distort the true meaning of the overthrow of Laplacian determinism. It did this by borrowing from classical mechanism the notion that a complete description was possible; one only had to consider chance as a singular cause. Systems philosophy was thus ambivalent even toward microscopic infinity. It could refuse to take Bohm's "subquantic states" seriously, even as it led the search for smaller and smaller particles. Systems philosophy leaned toward microscopic infinity just enough to switch theoretical attention from the external to the internal; just long enough to overthrow macroscopic infinity. The new focus was quite sufficient for the crowning achievement of systems philosophy: the Big Bang Theory of the origin of the universe.

The ambiguities introduced by the modern attempt to make microscopic infinity compatible with macroscopic finity are no easier to live with than the ones devised by classical mechanism to do the reverse. Both approaches ultimately ended up supporting a grand finity even in the areas in which they chose to specialize. In actuality, of course, microscopic infinity logically implies macroscopic infinity and vice versa. This follows from many of the previous discussions, particularly the one on "spacetime" involving the opposed concepts of ideal "solid matter" and ideal "empty space." Again, if we grant these to be merely idealizations, then we are assuming that they have no actual existence. Neither indivisible matter nor immaterial void is possible, although each portion of the universe reflects both to varying degrees. Without actually existing indivisible matter, there can be no microscopic finity, just as there can be no macroscopic finity without an actually "existing" immaterial void outside the universe. The upshot: the nonexistence of the universe is impossible.

We can no longer merely entertain either microscopic or macroscopic infinity; we must steadfastly assume both. The resulting assumption of *infinity*, the proposition that *the universe is infinite both in the microscopic and the macroscopic directions*, is the only form compatible with *causality* and *uncertainty*. Such an assumption is not to be taken lightly, as the struggle over *causality* and *uncertainty* indicates.

There is, of course, an unavoidable, necessary circularity to the argument for *infinity*. This is a characteristic to be expected if the universe was truly infinite and assumptions, rather than absolute presuppositions or *a priori*, were necessary for its study. Because it includes the macroscopic as well as the microscopic, *infinity* stands out so strikingly different from the currently accepted view that it leads, as we have seen, to a major reinterpretation of all our scientific assumptions. Now let us examine some of the factual evidence upon which the belief in *infinity* rests.

Quest for the Ultimate Particle

The ultimate particle has been the object of a continuous search ever since Democritus proposed it 2,500 years ago. In his view, the ultimate constituents of matter were atoms, hard little balls filled with an inert substance called "matter." These atoms were unprecedented in that, unlike other things, they could not be further subdivided. Also unlike other things, all atoms had identical properties.

The atomic concept, of course, was useful; matter does appear to consist of discrete particles. The atom was considered the basic building block of matter well into the nineteenth century before its supposed unchanging nature came under question. As more and more information on atoms was accumulated, it became obvious that all atoms could not be considered identical, as the atomists' assumption of microscopic finity demanded. True, the basic properties of the constituent atoms of a metal such as gold appeared identical, but the atoms of gold and the atoms of other elements differed in many ways. For example, a million atoms of gold did not weigh the same as a million atoms of silver. How could the atom be the ultimate particle if different atoms had different masses? There must be something inside these atoms—perhaps this something was the ultimate particle instead.

Sure enough, by 1897, J. J. Thomson had discovered the electron, proving beyond a doubt that the atom was divisible. This began a long series of discoveries that alternately raised the possibility of microscopic infinity whenever a subatomic particle was split, and lowered it whenever there was a failure to split. To this day, each subatomic particle, when explored with some newly invented technique, eventually yields still another, even smaller particle.

The electron has been succeeded by the quark as the smallest subatomic particle.[193] Will there be an end to this succession? Will an ultimate particle be found? One scientist felt sure that "matter is not infinitely divisible,"[194] while another reiterated that "no 'ultimate' individual or partless particle is known to science."[195] Indeterminists can assert that "the electron does not have other particles inside it,"[196] while determinists can just as dogmatically assert that the electron is just as inexhaustible as the atom.

In the specific, determinists always win out; there are now at least three different kinds of electrons, some of which emit neutrinos.[197] But who would be so foolish as to declare that this will always be the case? There can be no end to the debate between those who believe in microscopic infinity and those who do not. There is no experiment that could settle the question once and for all.

Looking for the Edge of the Universe

As we grow up, we find that there are no limits to our environment. Every door opens on another, and another, and another. The intellectual growth of humanity has followed a similar pattern. Our acknowledged environment has expanded from the village, to the continent, to the Earth, to the galaxy and beyond. Before the 1920s we thought we lived in an island universe situated within an infinite volume completely void of matter. But then, the discovery of other galaxies—over 100 billion at last guess—once again dashed indeterministic hopes that the environment was finite. If there was literally something "beyond physics," it had to be at least 10^{23} kilometers away and impossible to reach in less than 13.7 billion light years. Each time its vision dimmed, humanity faced the ancient metaphysical choice: either what is beyond physics is physical or it is not.

Today that choice requires a leap of faith just as much as it did in the past. In some ways our current ignorance of what lies beyond the reach of the largest telescopes is fundamentally no different from that of the pre-Columbian Europeans who were unaware of the New World. In hindsight, of course, it is easy to point out that those who assumed the environment was infinite in the macroscopic direction were scientifically correct. But is this likely to be true in the future? We can never know for sure; the widespread prevalence of the opposing assumption is proof of that.

To avoid macroscopic infinity, indeterminists today follow one of two paths. The first visualizes the known universe situated within, and perhaps expanding into, an infinite immaterial void. The second seeks refuge in the mathematics of Einstein's four-dimensional, finite universe. The simple deterministic alternative to such whimsy requires neither an immaterial void nor an unprecedented geometry.

Infinity: *Microscopic Plus Macroscopic*

As mentioned, classical mechanism emphasized macroscopic infinity and systems philosophy emphasizes microscopic infinity. Regardless of the special pleas one can make for one exclusive of the other, the two ideas logically imply one another. The indeterministic notion of the ultimate particle with no thing (e.g., nothing) inside it is of a sort with the indeterministic notion of a universe with no thing (e.g., nothing) outside it. The philosophical purpose of ***finity***, whether it be construed as microscopic, macroscopic, or both, is at some point to call a halt to *materialism*. On the other hand, the philosophical purpose of *infinity* is to proclaim the universality of *materialism*.

Describing *Infinity*

Those who support the concept of *infinity* are often asked to describe or even to define it. But, of course, a complete description of *infinity* would be a contradiction in terms; "As the universe is infinitely varied, it is very likely that only statements of infinite length can be true. … [T]he ontological structure of the universe is such that all universal statements of finite length *are* false."[198]

Nevertheless, most any child can begin a model of infinity by stacking blocks in all directions. Any attempt to enumerate the members of a class or to repeat a process endlessly amounts to a primitive model of infinity. The method of simple enumeration, for example, was used by George Gamow[199] in retelling the story about the hotel with an infinite number of rooms. Whenever a new guest arrives, the previous arrival makes space available by moving into his predecessor's room, who, in turn, moves into his predecessor's room. Each guest advances one room each time a new guest arrives. Thus, the infinite hotel with the infinite number of rooms can always accommodate an infinite number of guests.

Planck described infinite time by comparing it to the cooling of a hot iron in water. "The smaller the difference of temperature between the hot iron and the water the slower is the transmission of heat from the one to the other, and calculation shows that an infinitely long time passes before an equal temperature is reached. This means that there is always some difference of temperature no matter how much time is allowed to elapse."[200]

As models of infinity, these are typical of the system-oriented viewpoint. They are inadequate because, even though they attempt to model processes, the processes invariably occur in isolation and thereby develop a static nature. The same event is repeated endlessly. Note that these descriptions are dependent on the assumption of ***reversibility***. Planck's pseudoscientific illustration is not much better than Gamow's quixotic one. Both amount to a negation of *infinity* because, for the demonstration to proceed, it must occur in isolation.

The essence of *infinity*, on the other hand, lies in the possibility of relative nonisolation: convergence from the environment. In Planck's example neither the hot iron nor the water used to cool it could escape the impingement or the diminished impingement from the infinite number of things that lie outside of it. Planck first imagines and then calculates that the water will always be cooler than the iron, but the actual cooling of an iron must occur in a real environment that has a real temperature. As the temperature of the iron approaches that of the water, the impact of even one atom or photon from this environment could increase the vibrational motion of one of the water molecules enough to make the temperature of the water higher than that of the iron. The result: end of experiment; end of within-class infinity.

The mathematics to which Planck alluded was no proof of *infinity*, just as Plato's ideal geometric forms were no proof of their real existence. The success of mathematics as well as of science depends on its willingness to assume—in other words, to make a beginning. Only by divorcing itself temporarily from the infinite external world can mathematics or science reach a conclusion. Just as the real world intruded upon Plato's idealism, so does it intrude upon the necessarily finite mathematical physics of today. But try as we may, *infinity* won't go away; "The infinities that occur in QED (quantum electrodynamics) are clearly symptomatic of some profound shortcomings in our understanding of physics."[201] You bet.

These shortcomings, of course, are none other than those of systems philosophy itself. Our infinite universe refuses to be jammed into the finite, isolated container we have contrived for it. As explained under *uncertainty*, no theory can be complete, because any particular class of things is susceptible to interference from other classes of things. Whether we recognize our ignorance with formal mathematical symbols or in some other way, we still must recognize it. We invariably give up contact with the real world whenever we use mathematical axioms that "somehow avoid the concept of infinity."[202]

When it deals in specifics and ignores the rest of the universe, mathematics forces thought into the finite mode. When it deals in generalities and slips from its disciplined course, mathematics regularly runs into the notion of *infinity*. Well-trained minds of the twenty-first century persist in the grooves provided by systems philosophy. Subconsciously they know that if the universe is truly finite, as the cosmogonists say it is, then the mere thought of *infinity* also has no place in mathematics.

Mathematicians nevertheless have persisted with such thinking despite the cosmogonical fad. The development of the "nonstandard model" of infinity by Abraham Robinson is a case in point.[203] Previous models were based on a one-dimensional view of the "standard infinite line": the line one can imagine extending forward and backward for an infinite distance and consisting of an infinite number of segments. When the third dimension is considered, the picture changes drastically. One then imagines an infinite number of lines radiating from any point or segment of the standard infinite line. Each of these lines is, in turn, an exact copy of the original line, having infinite length and an infinite number of segments. The result is a "complex structure of worlds within worlds, with galaxies spread out in infinite distances."[204] This model, unfortunately of a piece with mere enumeration, is nonetheless an improvement in that it provides a three-dimensional framework for beginning a description of the real, infinite universe.

The Struggle for *Infinity*

In the interests of "healing the nineteenth century breach between science and religion,"[205] moneyed indeterminists succeeded in persuading scientists to accept their belief in *finity*. Although one may doubt the benefits for science, it was surely good for religion; "Since modern science is now committed to a view of the physical universe as finite, certainly in space and probably in time, the activity which this same science identifies with matter cannot be a self-created or ultimately self-dependent activity. The world of nature or physical world as a whole … must ultimately depend for its existence on something other than itself. … [I]n a word, modern science, after an experiment in materialism, has come back into line."[206]

This is nothing more than Aristotle's ancient, discredited metaphysics in sense I; what is beyond physics is not more physics, but non-physics. Determinists and indeterminists alike have learned that there is always more to the universe than meets the eye. They differ only on whether it is something or nothing.

Systems philosophy may accept microscopic infinity, but, by definition, it will never accept macroscopic infinity. To do so would negate the myopia upon which systems philosophy is based. To accept *infinity* is to accept all the other Assumptions of Science and to discard the anthropocentric view of the universe once and for all.

From the concept of indivisible matter held by the classical mechanists, to the concept of the immaterial void held by the spiritualists, the resistance to *infinity* has been strong. The quest for ***certainty*** and its search for the ultimate answer to the reason for the existence of the universe periodically calls a halt to the question begging. Therein lies its fatal error. Today curved space has replaced the celestial sphere. Timid minds still seek shelter from the godless specter of *infinity*. As always, it will be to no avail.

The Ninth Assumption of Science: Relativism

> All things have characteristics that make them similar to all other things as well as characteristics that make them dissimilar to all other things.

Whether or not we admit it, all thinking involves the comparison of one thing with another.[207] We try to understand what we do not know by comparing it to what we do. The world obliges us in this respect by presenting us with a never-ending series of material objects, no two of which are either completely dissimilar or completely similar. Whether it should do so at all times and in all places is, however, a matter of serious philosophical contention.

Relativism versus ***Absolutism***

While most people probably agree that comparisons are highly important, they tend to view the comparisons themselves in either of two ways: as absolute or relative. With the development of formal logic, the absolutist approach achieved early domination. As part of the search for ***certainty***, absolutists devised two primary laws that illustrate their thinking:

The Law of Identity or Equality, A = A, that is, every concept is equal to itself

The Law of Contradiction or Inequality, A ≠ A

What distinguishes relativists from absolutists is the degree of flexibility they exhibit in thinking about these laws. According to relativists, the concepts of perfect equality and perfect inequality are only idealizations useful for describing the intervening reality. Relativists believe that, in the strictest sense, both laws are false. There are no absolute equalities or absolute inequalities. The only way to consider any two things as exactly alike would be to ignore differences. There are no strict identities because all matter is in constant motion; no thing can be what it was just a moment before. Absolutists, on the other hand, tend to view objects as internally static, that is, containing matter without motion in accord with the assumptions of ***separability*** and ***finity***. Only in this way can they insist on the literal imposition of logical ideality upon reality.

Absolutism, the indeterministic alternative to *relativism*, is the belief that some things may be perfectly identical to or completely different from other things. ***Absolutism*** is consupponible with ***certainty*** and that bulwark of classical mechanism, the notion of finite universal causality. Only if an object could be described completely by a finite number of unchanging characteristics could it be absolutely identical to another object with the same description. And only then could its interactions with other objects be predicted with perfect precision. Anyone who believes this is possible must be considered an absolutist. Ironically, by this criterion Albert Einstein was an absolutist, not a relativist.

The philosophical opposition between *relativism* and *absolutism* arose early in the development of formal logic. The Greek sophists attacked the rigidity of logic simply by finding contradictions and exceptions in the statements of the logicians. The sophists were correct when they said such things as, “A white horse is not a horse because it is a particular horse and a horse is a general horse." A white horse becomes a horse in general, only if we ignore its color. In short, the concept of a general horse is an abstraction, an idealization we use to give a class a name, to think about it, and to communicate our thoughts to others. Only if all horses were identical could formal logic be completely adequate for their description.

For all the deficiencies pointed out by the sophists, the idealizations of formal logic were inescapable starting points for thinking. Even the lowliest animal must distinguish between food and nonfood. Mental activity itself involves elements of both *relativism* and ***absolutism***. Throughout their daily lives all sentient creatures find it necessary to *assume* what amounts to identities or equalities to provide some stable basis on which to act. As always, however, the problem for philosophy is to avoid confusing ideality with reality. For this we must use all the tools at our disposal, particularly language. For example, relativist terms such as *similarity* and *dissimilarity* more accurately reflect reality than absolutist terms such as *equality* and *inequality*.

The Similarity-Dissimilarity Continuum

To understand *relativism* one must also understand the problem of classification. In a sense, classification is one of the most important activities in science because its resolution comes with what science does best: make the subjective objective. This process requires an essential ingredient: cooperation. One observer may view two objects as similar because both objects have the same height; another may view them as dissimilar because the objects have different weights. Obviously, no agreement can be reached about similarity-dissimilarity unless the observers agree to compare the same characteristics. Until this is accomplished for a finite set of measurable characteristics, a classification or comparison must remain subjective rather than objective.

Reasoning by Analogy

An *analogy* is a comparison that emphasizes similarity over dissimilarity. All analogies stand or fall on the appropriateness of the selection of the characteristics that are deemed to be similar. Because there are no two characteristics that are *exactly* alike, all analogies are vulnerable to error. As theoretical constructs, analogies are used to predict that if many of the characteristics of two objects have a high degree of similarity, then some of their other characteristics will have a high degree of similarity also.

As implied before, analogy is crucial to the whole process of knowing. It is impossible for us to consider the unfamiliar without reference to the familiar. To understand a thing, we are forced to consider only a few of the infinite number of qualities that it possesses. We must reduce the complex to the simple and the unknown to the already known. When asked to describe a taste sensation we have not experienced before, we find it impossible to answer without drawing an analogy with some other food. Thus in describing the taste of frog legs, for example, we might say, "They taste like chicken with a bit of fish mixed in." How ever we put it, the description must have simpler elements than the thing described.

Obviously, if all things were alike, we would not need to make comparisons (we would not be here for that matter). The fact that we can, and must, make comparisons is dependent on the dissimilarities that eventually become sufficient to destroy any analogy. For example, one could say that a person is like an automobile; they both consist of atoms and are influenced by gravity. The statement would be true as far as it goes. Of course, one could as easily point out the dissimilarities between people and automobiles. After all, according to *infinity*, the number of similarities and dissimilarities is infinite.

An analogy, like an assumption, must lead to understanding and accurate prediction or it will be discarded as useless. Thus it is common for people to discard analogies that run counter to "common sense," or that predict an outcome with which they do not agree. Consequently, a particular analogy often finds acceptance only after the necessity for it becomes clear in the broad social context. Humans, for example, were not considered similar to other animals until the scientific and commercial advantages of the analogy outweighed the religious objections.

The method of thinking by analogy is certainly not an exclusive property of *Homo sapiens*. Other animals must also make comparisons to survive. Consider the plight of the starving predator whose favorite food has become scarce. It has no choice but to select another species that, by analogy, may be nearly as suitable for sustaining its life. The predator must continually abstract sense data from its environment, classify things into food and nonfood categories, and test its judgment in the external world.

In the above example it was advantageous to consider *Homo sapiens* and the predator as similar beings. I looked for similarities to understand the thought process in general. It is only by drawing such analogies that we can discover the connections between things in the universe. Without a plentiful use of analogy, a unified worldview is impossible. Thus, in following tradition, anthropocentric indeterminists who deny that such unification is possible or desirable tend to disparage analogies involving the comparison of humans with other animals. Through an ***absolutism*** of one sort or another they attempt to disconnect the human being from its history and its present surroundings.

Of course relativist and absolutist alike are free to object to the choice of characteristics and the conclusions reached by a particular analogy. Only an absolutist, however, would claim that an analogy is impossible. If one goes far enough in generalizing the bias against analogy, one ventures close to intolerance of thinking per se.

Reasoning by Disparity

A *disparity* is a comparison that emphasizes dissimilarity over similarity. All disparities stand or fall on the appropriateness of the selection of characteristics that are deemed to be dissimilar. Because there are no two characteristics that are *completely* different, all disparities are vulnerable to error. Like analogies, disparities are approximations. We reason by disparity to divide things into different physical or mental categories, while at the same time, we reason by analogy to place things into one of two or more categories. Disparity is the result of divergence, analogy the result of convergence.

Categories or classes necessarily must form to the degree that things are isolated from their surroundings; they must dissolve to the degree that things are nonisolated from their surroundings. Although the classification process is a result of mental activity, it reflects the actual differentiation and integration of matter, as well. To achieve the closest correspondence between the two, we must consciously use both analogy and disparity in formulating the experiments for finding out which is applicable in a particular context.

Similarity Analysis

As scientists, it generally is important to reach agreement regarding a particular comparison. We do this by identifying the significant qualities of the objects to be compared and by collecting data in an effort to quantify those qualities. In transforming the subjective into the objective we must traverse three levels of comparison. The first level is purely qualitative and the most subjective. The second level is an attempt to measure characteristics in an objective way and then to compare the two sets of measurements in a subjective way. The third level is an attempt to compare the measurements themselves in an objective way.

At the elementary level of comparison, mathematics is not used in an explicit manner. Having no knowledge of simple arithmetic, a good witness, for example, might identify a suspect in a lineup. The sophistication of the elementary method is dependent on the number and significance of the qualities considered. Whether a person is short or tall is significant, but obviously this is insufficient for distinguishing him or her from all other humans. The inclusion of other characteristics such as sex, body build, hair color, and skin color narrows the possibilities still further, until, with enough of them, the person is uniquely distinguished on a purely qualitative basis. We admit the deficiencies of this highly subjective method whenever we attempt to mathematize the comparison by offering numerical estimates of height, weight, and age, thereby moving on to the intermediate level of comparison, the actual taking of measurements.

The intermediate level of comparison has only one general requirement: the actual measurement of some of the characteristics of the two things to be compared. In addition to the number and significance of the characteristics measured, we are also concerned here with the degree of accuracy (closeness to the "true" value) and precision (repeatability of the measurement). If we are to compare the measurements of one thing as a whole with the measurements of another thing as a whole, we can do it in either of two ways. The simplest is a visual examination of the data during which we compare the two measurements of a particular characteristic and then turn our attention to the data for the next characteristic. After evaluating two columns of such data we get an overall impression concerning whether the two objects are similar or dissimilar. In this intermediate method, the process of measurement reflects a degree of scientific maturity, but the subsequent handling of the data does not. For this we require additional mathematics that will help to decrease the subjectivity inherent in visual examination.

The advanced level of comparison uses a mathematical or statistical method for comparing the data acquired by measurement. There are numerous and very sophisticated methods for using mathematics in comparing two sets of data. The one I devised decades ago also happens to be about the simplest.[208] The gist of it is given as equation 3-2, a formula for calculating a single value that reflects the degree of similarity between two objects having numerous measured characteristics:

$$d(A,B) = \frac{\sum_{i=1}^{n} R_i}{n} \qquad (3\text{-}2)$$

Where:

R_i = X_{iA}/X_{iB} if $X_{iB} > X_{iA}$
R_i = X_{iB}/X_{iA} if $X_{iA} > X_{iB}$
X_{iA} = Measurement for characteristic i of object A
n = Number of characteristics measured

There are many such formulas, but this one, the SIMAN (sī′mən) coefficient, has special advantages.[209] In brief, we compare two objects by dividing the measured value of a characteristic of one object by the measured value of the same characteristic of the other. The basic rule for the calculation is that, for each variable, the divisor must always be the larger of the two mesasurements.

The SIMAN coefficient nicely illustrates the nature of the similarity-dissimilarity continuum. "Perfect" similarity—that is, identity—would result in a SIMAN coefficient of 1, while "perfect" dissimilarity would result in a SIMAN coefficient of 0. Comparisons of real objects always result in SIMAN coefficients less than 1 and greater than 0. Even measurements of the same object taken at two different times do not give values equal to unity. Both the thing being measured and its surroundings, including the measuring device, are continually changing. This is why no real thing can produce absolute values. The so-called "absolutes" of the idealist are purely imaginary. Pi, for example, can be *calculated* at least a million more decimal places than it can be *measured*. The diameter and circumference of a real circle fluctuates over time; only the imagined, "ideal" circle does not. When real things are being compared, SIMAN coefficients of 1 or 0 reflect mathematical rounding rather than the actual existence of ideal things.

The SIMAN coefficient for the comparison between a six-foot tall person and a five-foot tall person would be 0.833. Comparisons between very tall people and very short people result, of course, in much smaller values. There is no limit to the number of characteristics that can be used for a comparison. For example, if the six-foot person and the five-foot person had weights of 200 and 250 pounds, respectively, a comparison would yield a SIMAN coefficient of [(5/6) + (200/250)]/2 = 0.817 *for these characteristics*. The conclusions to be drawn, if any, from such comparisons depend on the context, which in this case generally would be a third person. Then, we can give a definitive answer to the question, "is person A more similar to person B or to person C in regard both to height and weight?" As long as agreement can be reached as to which measurable characteristics are to be compared, we can decide objectively as to which two of three or more people or objects are most similar.

In spite of all this, and because the number of characteristics is infinite, similarity analysis always has a degree of subjectivity. This enters at the beginning in the selection of the characteristics deemed significant as well as in the portrayal of their interactions. It also enters at the end when a decision must be made regarding the level of similarity acceptable for a satisfactory answer to the question being asked.

Examples of the Application of Relativism

The Electron

Both in philosophy and in science, *relativism* has traditionally taken a back seat to ***absolutism***. You remember that the atomists claimed that each atom was identical to all others. Classical mechanics essentially adopted the same viewpoint, leaving itself open to the criticism of those who, like G. W. Leibniz, asserted that there are no two things that are perfectly identical. It is ironic that even after the theory of relativity became popular, ***absolutism*** still had its defenders in physics. This kind of thinking was illustrated in the words of Max Planck: "In contradistinction to chemical atoms all electric atoms (electrons) are found to be uniform and to differ from one another only in their velocity."[210]

In 1957, David Bohm echoed Leibniz's assumption and showed the connection between *relativism* and *infinity*. "Because every kind of thing is defined only through an inexhaustible set of qualities each having a certain degree of relative autonomy, such a thing can and indeed must be unique; i.e. not completely identical with any other thing in the universe, however similar the two things may be."[211]

In regard to electrons, Bohm claimed that it is "always possible to suppose that distinctions between electrons can arise at deeper levels."[212] Both *relativism* and *infinity* lead to the rejection of the possibility of actual identities in nature; both continue to be substantiated by the accumulating evidence. The debate on the electron was ended when experiments showed that there are at least three different types.[213]

The "Conservation" of Parity

Another test of *relativism* involved the rejection of the "conservation" of parity in quantum mechanics. In brief, parity implied that atomic nuclei oriented in a particular direction would emit beta particles with the same intensity as they would when oriented in the opposite direction. Experiments finally showed that emission was not identical in both directions.

There are two ways of interpreting this rejection of the "conservation" of parity. In the indeterministic view, set forth by Ernest Nagel,[214] it is considered as a generally ignored falsification of *conservation*. In the deterministic view, the so-called "conservation" of parity was actually a restatement of ***absolutism***. Being blinded by mathematics, its author had forgotten that parity, like perfect identity and perfect equality, is merely an idealization. What the idealists who supported this erroneous application were attempting to conserve, in effect, was the *idea* that both sides of a thing could be identical. Because identities do not exist in nature, because each thing is in continuous motion and is not even identical to itself from moment to moment, the attempt failed.

To Think is to Compare

However one looks at the similarity-dissimilarity continuum—whether with a similarity coefficient or with some less quantitative view—one finds that comparisons on that continuum are fundamental to the method of thinking itself. Mostly we try to find the similarities in things, analogies, which are attempts to discover the familiar in the unfamiliar. It generally is easier to see what is different after we have seen what is alike. This bias extends to the language. There is no adequate antonym for the word *analogy*, although the word *disparity* seems the best available. One may try to draw analogies, ignoring certain dissimilarities, or one may point out disparities, ignoring certain similarities. Our thoughts are forced into either of these two modes, for it is impossible to compare two things in terms of a single characteristic that is considered both the same and different at the same time.

The Ninth Assumption of Science, *relativism*, concerns the comparisons that are the basis for all statements, scientific or otherwise. All comparisons lie on the similarity-dissimilarity continuum. In nature, there are no absolute equalities and no absolute inequalities. Moreover, there are no analogies or disparities that cannot be contested by someone with contrary motives. As a result, the comparisons that we make in science and in everyday life have a single criterion for validity: usefulness.

The Tenth Assumption of Science: Interconnection

> All things are interconnected; that is, between any two objects exist other objects that transmit matter and motion.

The word *universe* portrays a fundamental property of existence: *interconnection*. Whenever we try to think of any particular thing as a unity, we must view its parts as being interconnected. But to consider something as a part we must focus on it alone, momentarily suspending attention to its surroundings. Our thoughts necessarily must travel from parts to wholes and back again,[215] first viewing a thing as isolated from its surroundings, and then viewing it as a part of them.

Relativism encouraged us to look at this aspect of the world by looking for the characteristics that make an object dissimilar from its surroundings, and then by looking for the characteristics that make the object similar to its surroundings. After having shown the ways in which two parts of the universe were unrelated, we showed the ways in which they were related. After disconnecting the world conceptually (analysis), we put it back together again (synthesis).

In a similar vein, the Tenth Assumption of Science, *interconnection*, recognizes that the world, like the ways in which we can view it, has both a discontinuous and a continuous nature. It is obvious that the universe contains countless examples of more or less discrete material objects and that each object displays a continuity within itself, but less obvious are two somewhat more sophisticated observations:

1. That the discontinuity between the object and its surroundings is not absolute—each contains things common to both, and
2. That the continuity within the object is not absolute—each object contains concrete discontinuities within.

The universe nowhere contains either empty, discontinuous space or solid, continuous matter. The ideas of absolute discontinuity and absolute continuity are only that: ideas. As usual, the reality lies in between, a reality we nevertheless cannot express without those ideas. The philosophical choice we need to make is not between an assumption of continuity and an assumption of discontinuity, but between a deterministic assumption that includes both of those ideas and an indeterministic assumption that does not. Thus, if discontinuity and continuity are to be considered qualities of *every* portion of the universe, we will have a lot of explaining to do whenever we are confronted by a portion that at first seems to be describable by one or the other, but not by both. Outer space is a good example. How can both qualities, discontinuity and continuity, apply to what is commonly envisioned by the naïve realist as completely empty?

Even well-known materialists have lapsed into a confused idealism on this subject, apparently for lack of a clear definition of *space*. "Space is continuous in the sense that between any two arbitrarily selected spatial elements (large or small, near or remote) there must always be in reality an element that joins them into a single spatial extent; in other words, between the elements of spatial extent there is no absolute separateness or isolation."[216]

What is this supposed to mean? As I see it, an "element of spatial extent" can represent one of two possibilities: either it is something or it is nothing. If it is nothing, then it is indeed empty space and hardly could form a connector of any sort. If an "element of spatial extent" is something, then it must have matter within it and, therefore, it can be considered to be an object. As an object (something), rather than a non-object (nothing), it must be capable of transmitting matter and the motion of matter between what otherwise would be at least temporarily isolated "elements of spatial extent." Thus is born *interconnection*, the deterministic assumption that *all things are interconnected; that is, between any two objects exist other objects that transmit matter and motion*. Through this objective and materialistic means we reject ***disconnection***, the opposing indeterministic assumption that *between any two objects there can exist solid, continuous matter or empty, discontinuous space*.

Disconnection Through the Idea of Perfect Continuity

Interconnection assumes that the continuous quality of the universe is produced by discrete objects that, above all, are in continuous motion relative to each other. It might be objected that, with every two objects having another interposed between them, an infinite progression would produce solid matter of infinite density. One might wonder why the universe is differentiated at all. Such a view, however, would amount to a self-contradiction, because *interconnection* assumes, along with *infinity*, that matter is infinitely subdividable to produce two things: "matter" and "empty space." There is no end to the interposition of objects, which themselves contain two things: "matter" and "empty space." For the universe to be completely undifferentiated, all its "parts" would have to be identical—a contradiction of *relativism*, as well as of the word "parts." Being solidly "connected" would, in effect, amount to a ***disconnection*** because there would be nothing to connect. The word *connect* implies the existence of more than one thing.

By hypothesizing the existence of perfect continuity, classical mechanism tended to use ***disconnection*** to do what all scientists must do in one way or another: ignore part of the universe. A solid, matter-filled object ceases to be of interest to science because it contains no thing within it that can be studied. Through this derivation of ***disconnection***, mechanists naturally were led to overemphasize the external interactions of their model.

Disconnection Through the Idea of Perfect Discontinuity

The other way of deriving ***disconnection*** from the idea of perfect discontinuity was, of course, also present during the reign of classical mechanism, but has achieved an even more important place in systems philosophy. Today, the insides of the things we study cannot be ignored as easily as in the days of primitive scientific instruments. The notion of the solid, matter-filled object has been shoved into an ever-tighter corner, while the space between objects is still construed by many as though it were perfectly empty. By the empiricist, positivist, and operationalist[217] standards from which systems philosophy evolved, space is to be regarded helplessly as "perfectly empty" until evidence to the contrary is demonstrated. This ***disconnection*** of the object from its surroundings places renewed emphasis on the object itself. Derived in this way, ***disconnection*** leads to the overemphasizing of the internal and the ignoring of the external.

As the prevailing scientific worldview, systems philosophy generally achieves the first step in science. It correctly distinguishes the object or system from the rest of the universe. It goes part way toward achieving the second step by studying the interrelations between the parts within the system and, at times, even attempting to relate the system to its surroundings. But in general, systems philosophy tends to assume ***disconnection***, always failing to the degree that it refuses to recognize that the surroundings of the system are as important as the system itself.

In a moment of great optimism, David Bohm wrote, "The universal interconnection of things has long been so evident from empirical evidence that one can no longer even question it."[218] Similarly, Barry Commoner, one of the first to emphasize the importance of the environment, declared that in ecology, the most important law is: "Everything is connected to everything else."[219] It would seem that the belief in *interconnection* would be commonplace, but, as I will show, this is unfortunately far from true. It is the special mission of indeterminists to point out that the connections between things seldom are as obvious as Bohm and Commoner imply. Furthermore, *interconnection* may be a useful generalization, but it remains for us to show, in each specific instance, what the connections are. Whenever we fail to do that, indeterminists tend to assume that the connections do not exist.

In the spirit of positivism, the belief in ***disconnection*** asserts that what lies between any two objects can just as easily be considered nothing as something. If by interconnection we only mean that objects exist in the same universe—though at a distance from each other—then Bohm's optimism is well taken. But if it is to mean more than that, if we are to reject the positivistic view altogether, then we need to show that things do not simply exist in the same universe, but that their motions invariably influence the motions of other things.

Historically, the belief in ***disconnection*** precedes that of *interconnection*. After all, we begin life by believing that the rest of the world can be disconnected from us with a flick of the eyelids. Only with experience do we overcome solipsism and the tendency to view the world in a discontinuous fashion. About midway through this development it is natural that we should become dualists, assuming interconnections for some parts of the universe and denying them for others. Not being able to see all the connections between things, we continue to harbor the suspicion that, in some cases, there are no connections. As dualists we may be satisfied with a disjointed "worldview." It is only after experience produces a grander vision that we learn to translate "Weltanschauung" as one word.

We really cannot know for certain whether or not the universe is properly described by *interconnection*. Like the belief in *causality*, the attempt to see the world as a unity must rest to some degree on "faith." Although the second step in science is to discover interconnections—the motions, the causes of effects—we are not always able to do this. We inevitably run out of evidence for the proposition that "between any two objects exist other objects that transmit matter and motion." It is ironic that at one time the hypothesizing of things for which there was no direct evidence was pretty much left to indeterminists. Today, however, it is the determinist who believes that interconnecting objects must exist, while it is the indeterminist who more often believes that they do not.

As implied in the section on *complementarity*, the belief in ***disconnection*** leads to the idolization of the system itself as the source of its own development. If a thing is not subject to interactions with other objects in its surroundings, then it would exist like the solipsist: all alone in a universe supposedly of its own making. Insofar as we distinguish among things, but fail to relate them to other things, we reveal a juvenile bias in favor of ***disconnection***, the extreme of which was manifest in sentiments attributed to Leibniz: "In every created thing God implanted the law of its own individual being, so that each being in the world is independent of and develops independently of all other things, following only the law of its own individual destiny."[220]

Today's systems philosophy repeats the same basic error. It begins with the child's egocentrism, develops along with the bourgeois notion of individualism, and retreats, finally, to the citadel of free will. The illusion is maintained only by mentally disconnecting oneself from the environment of the present as well as from the memory and evidence of the environment of the past. Solipsism, egocentrism, individualism, anthropocentrism, and systems philosophy are merely variations on a theme.

To overcome this delinquent heritage let us review some of the supposed "***disconnections***" on which it is founded.

Search for the Universal Disconnection

Like the search for the ultimate particle and the edge of the universe, the search for a universal ***disconnection*** fails with each improvement in knowledge. What first promises to be an absolute separation between an object and its environment is later found to be only a relative separation. According to *complementarity* there can be no such thing as a completely isolated system. All objects exist in reality between the two ideals of complete isolation and complete nonisolation. There is always a transition zone or interface containing elements of both the system and the environment, a fact even recognized occasionally by the systems theorist.[221]

Absolutists believe otherwise. For them, the system is the system and the environment is the environment. Even as they dismiss the generalization that all things and their surroundings must necessarily undergo dynamic interaction at all times, their own bodies demonstrate against ***disconnection***.

We are mostly water. When this water is inside the body we consider it part of ourselves, but after it has been exhaled in the breath we do not. At what point should we consider this water to be nonhuman? As it exits the mouth? As it leaves the surface of the lungs? Where does the human being end and the environment begin?

Our skin daily loses epidermal cells that are continually being replaced. While these cells are still alive there is little question of their being part of the body. Long after they expire, the old cells lie loosely upon the skin as so much dead weight—they are actually part of the environment. Other cells are more firmly attached to the skin, although they may have died only moments ago. Still others have only a few moments to live. When a cell is alive and firmly attached it is clearly part of the body; when it is dead and loosely attached it is clearly part of the environment. The more closely we examine the transition between these two states, the more we must rely on arbitrary definition to maintain the belief in ***disconnection***.

Before the invention of the microscope and the discovery of the molecular nature of things, the case for ***disconnection*** was much stronger than it is now. For instance, as recently as 1870, chemists looked on the transition from one chemical phase to another as a support for ***disconnection***. They thought of the boundary between phases as absolute. A liquid was a liquid and a vapor was a vapor. Transition states intermediate between liquid and vapor were considered theoretically impossible, and the lack of data tended to support this view. All this became untenable after it was shown that liquid actually was transformed into vapor through a series of relatively homogeneous gradations in which many of the properties of both liquid and vapor were present at the same time.[222] So many phenomena exhibit such transition states that now they are cause for a general principle in chemistry.

Interconnection is closely allied with *conservation*. A thing is transformed into another thing only as it gains or loses matter or motion to other things in its environment. If this exchange were not possible, then the only way for things to come into being would be through miraculous ***creation***: the making of the material out of the nonmaterial. Any denial of the system-environment relationship amounts to a reiteration of the belief in ***creation*** as well as of ***disconnection***. As we have seen in the discussion of *complementarity*, such remnants of our indeterministic heritage are still very much active in the discipline of thermodynamics. As always, the best use of a deterministic assumption is at the point where data are scarce and speculation is rampant. One place where this occurs is in the study of the submicroscopic.

The Interquantic Interconnection

With quantum mechanics, physicists arrived at what was generally regarded as the culmination of the search for a universal ***disconnection***. The transitions between energy levels within atoms occur by means of quantum jumps from one state to another. In the conventional view, the "transitions between these states are therefore not through a continuum of intermediate states."[223] David Bohm had an alternate view of subatomic phenomena: "Between the stable frequencies of oscillations exist unstable regions, in which the system tends rapidly to move from one stable mode to another. If we suppose that these transitions are very rapid compared with processes taking place at the atomic level, then as far as purely atomic phenomena are concerned they may be regarded as effectively discontinuous. Nevertheless, at a deeper level, they are continuous."[224]

At the atomic level, we know that when an electron is knocked out of orbit by a photon, the electron picks up a full quantum of motion. It is not possible for electrons and photons, indeed any of the particles we know of, to exchange a partial quantum. And yet *interconnection* and *infinity* demand that subquantic exchanges must occur somewhere in the subatomic hierarchy. To demonstrate these, we would have to discover yet another level of particulate phenomena that would correspond with such subquantic exchanges of motion. Thus we expect that the particles we may eventually find *within* electrons and photons would interact with each other at the subquantum level rather than at the quantum level. It is presently unclear how or if we will be able to detect such phenomena. Even if this is achieved someday, indeterminists still could point to the lack of evidence for a "subsubquantic" level in support of ***disconnection***. The new breed of determinist, however, will continue to assume that matter is infinitely subdividable and that the exchange of motion between those infinitely subdividable particles is not restricted to the quantum. We have rejected Greek atomism in the study of matter; let us reject it in the study of motion.

The Intergalactic Interconnection

At first look, outer space appears to be an indeterminist's paradise, an irrefutable contradiction of *interconnection*. To the uninstrumented eye, the regions between the stars seem to contain nothing at all, just empty space. If there is anything "connecting" the astronomical objects, it certainly is not obvious. Nevertheless, there are plenty of reasons to believe that *interconnection* holds here, too.

We believe the connection between two things to be direct and certain when matter is seen to extend from one to the other, such as in the case of the wire between two utility poles. What we sometimes forget is that the matter between the poles is really not "solid" in an absolute sense—it consists of atoms that are mostly "empty space." Unless we wish to resurrect atomism, we must agree that this holds for all other objects in the universe as well. For a connection to occur between two objects, we merely require there to be something else between them. This something else need not be "solid" matter.

At one time, astronomers also thought that the regions between the stars were void of matter. This was not surprising, partly because their early instruments were incapable of detecting matter there, and partly because their belief in *interconnection* was weak; they were mostly positivists after all. Of course, with the improvement in instrumentation, astronomers found that the interstellar regions contain gas and dust that form at least a partial interconnection.[225] Between the galaxies, too, areas formerly thought to be empty are nothing of the kind. Evidence is now accumulating in favor of an intergalactic interconnection consisting of various types of matter, which, although not always resolved with the strongest telescopes, may be detected in other ways. Research concerning the sun, for example, reveals a continuous emission of high-speed particles, many of which eventually leave the galaxy to travel through the intergalactic regions as part of the universal interconnection. Even those who still support the ballistic theory of light[226] must admit that space is not empty when light is traveling through it.

There is one other way of thinking about the universal interconnection. Beginning with Aristotle's idea of the impossibility of a vacuum and ending with the notion of a "neutrino sea,"[227] theorists have advanced the notion of ether, a medium permeating all things. Like the determinism-indeterminism struggle itself, the ether concept has gone through alternating periods of acceptance and rejection,[228] with recent work on the fringes of physics once again providing typically unheralded support.[229]

At first, experiments on atmospheric pressure and the production of modest vacuums led to the view that universal space was absolutely empty. Then the notion of a universal medium returned when the discovery of the wave nature of light seemed to require a medium to complete the analogy with other types of wave motion. This view survived until about 1910 when the Michelson-Morley experiments and special relativity led to its widely acclaimed rejection.

The historical ambivalence toward the ether is particularly reflected in Einstein's work. He has gone on record as thinking that the ether was irrelevant (1905),[230] unnecessary (1907),[231] necessary (1922),[232] unnecessary once again (1938),[233] and finally, immaterial (1961).[234] At the end, Einstein refused to admit that he had left us with "completely empty space." Instead, his space was filled with a mathematically derived "field," which only incidentally contained no matter and had no material properties at all. In the currently accepted theory, light is viewed as both matter and motion, and the ambivalence remains. But the eventual return to the wave theory of light will require some kind of material medium that would at the same time be part of the intergalactic interconnection.

Always, the region between objects and outside of objects has been a source of mystery. Because matter in "empty space" could be detected only with difficulty, it was usually assigned a lesser importance than the matter of the objects themselves. This naturally supported the system-oriented view that, by definition, fails to recognize the surroundings of the object to be as important as the object itself. To discard the bias of systems philosophy we must accept *interconnection*, and in so doing we must discard the concept of space as empty.

In the past, what we have called empty space has always turned out to contain matter. Outer space, formerly thought to be empty, is really filled with all manner of particulate matter. Even if one does not favor a new kind of ether, one can no longer be assured that the intergalactic regions are void of matter, and thus are evidence for a universal ***disconnection***.

The Necessary Connection

The inclusion of *interconnection*, *relativism*, and *infinity* in a set of assumptions necessarily makes the reasoning somewhat circular; each assumption must have a degree of commonality with each of the others. But, of course, consupponibility without *interconnection* is a contradiction in terms (Fig. 3-1). This is why you will never find a concordant explanation of the fundamental assumptions underlying classical mechanics or systems philosophy. Without *interconnection*, logical consistency is forced to yield to the persistent indeterministic claim that a unified worldview is impossible.

There is good reason indeterminists often maintain that assumptions are unnecessary; when placed side by side, the indeterministic alternatives to the Ten Assumptions of Science are contradictory and nonsensical. They result in a logical jumble startling for its incoherence. Mercifully, the mental effects produced by the indeterministic alternatives can occur only in the heads of those who temporarily abandon ***disconnection***, attempting to find the interconnections among their own assumptions. At the outset, such a venture is unpromising. One must prepare for gross confusion even to begin a description of it.

The Compleat Indeterminist

One might suppose that in the fantastic world of the compleat indeterminist there are no causes and no effects; things happen for no reason at all or just by absolute chance, which is also no reason at all. Paradoxically, there is no *uncertainty* in this world; everything is certain. Complete and perfect answers to questions are known even though this world is completely acausal. It is not always well known where the answers come from—perhaps they mysteriously appear and disappear like the material things and the motions of matter created and destroyed either by the spirit outside or the imagination inside. In this world, **reversibility** is the watchword, for time flows in both directions; events are repeated in endless reverie. In this strange world, there exist objects that are perfectly motionless inside and out. Nothing really happens because contact between these isolated objects never occurs. Each of the objects is its own ultimate particle; there is nothing inside of it and nothing outside of it. Many of the objects, however, are completely identical and others are completely different from other objects, although this cannot be true either because the ***disconnection*** between all the objects is absolute. In short, the world of the perfect indeterminist is *logically ridiculous*. Words cannot express adequately the confusion that abounds when one attempts to apply the indeterministic alternatives to the Ten Assumptions of Science.

Of course, modern indeterminists dare not go that far. Instead, they broach just a little ***disconnection***, just a little ***acausality***, just a little this and that, to avoid the implications of determinism. Once the logical roots of these derivative ideas are laid bare we can see how they form impediments to theoretical and practical progress. The modern derivatives then become no less absurd than the extremes posed by Berkeley in his day.

Interconnections Among the Assumptions

The Ten Assumptions of Science, on the other hand, form a web of interconnections that are themselves worthy of lengthy study. With limited space here, only a few of the major interrelationships can be mentioned. With *materialism* we assume that, even though we are sentient beings, we are part of something much larger. As material portions of a material universe, we cannot do otherwise than obey laws similar to those we try to ascribe to other things. With *causality* we assume an unbroken causal nexus that, because of its infinite character, is only partially available to our understanding. According to *uncertainty*, we may discover the most significant causes for a particular effect, always improving on the description after interacting with the external world. Although these descriptions cannot be given in terms other than of matter and the motion of matter, we assume with *inseparability* that matter and motion comprise an inseparable reality. Motion without matter and matter without motion are impossible, and it makes no more sense to try to conceive of matter *as* motion or motion *as* matter. With *conservation* we propose no beginnings or endings for matter and the motion of matter, an idea reiterated with *complementarity*, which states that the Second Law of Thermodynamics is a law describing divergence, while its complement is a law describing convergence. According to *irreversibility*, each movement of each portion of the universe is unique—no two combinations or dissolutions occur in the same way twice. Each object has a unique relationship to the rest of the universe at any moment. This characteristic of time is consistent with the assumption of *infinity*, that the universe is infinite in both the microscopic and the macroscopic directions. This, in turn, is consistent with *relativism*, which states that the manifestations of matter nowhere appear identical in two different places or at two different times. Furthermore, we do not expect to find any two things that are *completely* dissimilar and therefore independent of the *interconnection* that describes the universe.

Assumptions and the Infinite Universe

In elaborating upon the Ten Assumptions of Science, I have tried to concentrate on areas where disagreement most often occurs, to show the fundamental differences between the deterministic and indeterministic viewpoints. The existence of these disagreements proves that these statements are assumptions—that is, matters of opinion. To make predictions, we must formulate assumptions, because in an infinite universe there is no obvious starting point. Our formulation and choice of assumptions must, of necessity, be based on our individual experiences with the world. And while no two experiences, and thus no two views of the world could be identical, their similarities must produce assumptions reflecting our unavoidable interaction with the external world. The explication and refinement of these assumptions is a never-ending process.

The idealist philosopher R. G. Collingwood rightly claimed that science is based on presuppositions. This is tantamount to saying that science is based on "faith" rather than "fact." Presuppositions, he said, are logical starting points unrecognized and unexamined by scientists as long as they get pleasing results. Presuppositions become assumptions just as soon as they are stated—a process likely to occur only when results are not so pleasing. For me, the image of the entire universe exploding from a mathematical singularity was the last straw! Not being pleased, I delved into the subject and brought forth the assumptive choices stated in this chapter.

Collingwood somewhat unwittingly insisted on consupponibility—the proposition that if you can assume one assumption within a constellation, you must be able to assume all the others as well. Unfortunately for his idealistic cause, this amounted to a clarion call for a new kind of determinism, one based on the assumption that the universe is both microcosmically and macrocosmically infinite. In the final analysis, the opposing assumption of ***finity*** does not permit the logical interconnections required for consupponibility. In developing these Ten Assumptions of Science I confronted numerous contradictions based on the conventional belief in ***finity***. Once I discarded ***finity***, the logic fell neatly into place.

The outcome of this inquiry, nevertheless, must be regarded as radical by today's standards: the universe had no beginning and will have no ending; time is motion; light is motion; there are only three dimensions; there is an ether; there is a simple mechanical complement to the Second Law of Thermodynamics. And last, but not least, these neatly consupponible assumptions support the replacement of the Big Bang Theory by the infinite universe theory.

Once I could overcome the idealizations of my youth, the philosophical possibilities were endless. Heretofore, I had been asking the wrong question about the universe: why is there something, rather than nothing? The answer is that *nothing*, like completely empty space, is only an *idea*, just like *solid matter* is only an *idea*. As shown time and again in our experiments, the reality exists between these two idealizations. It turns out that it is impossible for the universe *not* to exist—everywhere and for all time.

The implications of these ten assumptions are so profound that the challenge to the Big Bang Theory seems almost incidental. We no longer need suffer the indignities of non-Euclidean curved space, massless particles, matterless motion, and a Second Law of Thermodynamics without its complement. In applying these assumptions, one sees quite a different world than most of us have been taught to accept. Those who thought the parts of the universe were a meaningless jumble of objects out of control will be encouraged instead to see the order that is there.

Science and philosophy make accelerated progress when rapidly changing material conditions force people to seek the greatest accord between ideas and reality. Long-held philosophies suited to humanity's early development are becoming less and less viable. The myopic characteristic of today's scientific worldview, systems philosophy, will be discarded as the "environment," previously neglected, becomes increasingly prominent as a factor in our survival. As we reach our ecological "carrying capacity" of 10 billion people, we will devise a scientific worldview that strives to achieve a theoretical balance in our consideration of the insides and the outsides of every single portion of the universe—including our own species. Systems philosophy will be discarded as microcosmic and mechanism will be discarded as macrocosmic. Only a unification of the two will be adequate for humanity's new status as a species in tune with its surroundings. The remainder of this book provides an outline of that unification.

Part Three

The Method

Chapter 4

Theory of the Univironment

Between macrocosm and microcosm there is unity and interaction.[235]

The Ten Assumptions of Science provide the foundation for a system of thought that has some interesting consequences for us to consider. To do this efficiently we require a unifying theory that will enable us to call attention to certain parts of the universe without completely ignoring the rest. The theory that does this is both singularly simple and infinitely complex. I begin by redefining two words, inventing another, and presenting the theory as the claim that *the motions of a thing are determined equally by what is inside of it and by what is outside of it.*

What could be simpler? And yet, as I have been saying, both the inside and the outside of a thing are infinitely complex. No intelligence could *completely* understand the motions of a single thing. By regarding all things as matter in motion we may have learned very little, but by insisting that these motions be considered as relations between things and their environments we will have learned much.

We need not comprehend all scientific data to formulate the Scientific Worldview. We only need to grasp the essential features of a situation, compare these to other situations, and select the best analogy for predicting the future. However we do this, we will be using the method of abstraction, which has been beautifully defended in a famous statement by Paul Samuelson:

> Even if we had more and better data, it would still be necessary … to simplify, to abstract from the infinite mass of detail. No mind can comprehend a bun-

> dle of unrelated facts. All analysis involves abstraction. It is always necessary to idealize, to omit detail, to set up simple hypotheses and patterns by which facts can be related, to set up the right question before going out to look at the world.[236]

All abstraction, then, is a form of idealization, the result of postulating things that do not exist and events that do not occur in order to learn more about things that do exist and events that do occur. Our statements and descriptions of a thing always amount to idealizations or reductions because they are finite, whereas the thing itself, as well as its environment, has infinite properties. The predictions derived from abstractions cannot be infallible because they cannot have infinite length and infinite detail. Even so, they are indispensable.

It is possible to idealize, to abstract, from either an indeterministic or a deterministic perspective. Classical mechanists abstracted from the environment, failing to consider adequately the thing itself. Systems philosophers abstract from the thing itself, failing to consider adequately its environment. Both have failed to give the proper emphasis to the relations between the thing and its environment. If we are to achieve a unified worldview, our method of abstraction must consider at the same time the thing, its environment, and the relations between them. We can proceed toward this perspective by first reviewing some pertinent, though ancient, ideas.

Microcosm and Macrocosm

History of the Microcosm

The attempt to consider things and environments as a fundamental unity is nothing new. In one of his better moments Aristotle acknowledged that parts and wholes are intimately related when he used the intriguing term *microcosm* for the first time. The small, the micro, was a part of the large, the cosmos. This single word contained within it the seeds of that most powerful assumption: *interconnection*. Unfortunately, the word *microcosm* subsequently developed an idealistic tinge that diminished its usefulness. Today it has fallen out of favor among scientists, mostly because it presently connotes tiny worlds within worlds—miniature replicas, so to speak, of the cosmos itself. A nice thought, perhaps, but what can be done with it? Nothing we know of could be an adequate replica of the infinite universe.

The evolution of the word *microcosm* nevertheless was a step toward determinism because it granted validity to comparison on a universal scale. As part of the philosophical struggle, theories that used the image of the microcosm and its associated term *macrocosm* have been in and out of fashion.[237] The concept of the microcosm suffered arrested development like most other things during the Dark Ages and then returned with a flourish. Indeed, between 1400 and 1650 *microcosm* commonly was used in English literature as a synonym for *man*. The idea of man as the epitome of the universe was especially popular with the early humanists.

In the nineteenth century, Hegel transformed the notion of the microcosm into the related metaphor of the circle or sphere. With Hegel, as with many philosophers and scientists since, the notion of the microcosm took a microcosmic turn. Like today's systems philosophers, Hegel emphasized the idea of a totality in which the elements are fully complete parts, each expressing the perfect internal unity of the whole.[238] In achieving this imagined, self-contained unity, Aristotle's microcosm was unfortunately left without a cosmos. Hegel's most important student, Karl Marx, rejected the idea of a theoretical enclosure of any type. The idea of the microcosm lay abandoned.

In the modern era, a little-known philosopher, G. P. Conger,[239] was one of the most persistent advocates of the concept of the microcosm. For Conger, all objects were microcosms, epitomes of the universe as a whole. In an immense, difficult monograph,[240] he compared almost everything from soup to nuts, seeing an analogy in every corner of the universe. Unfortunately, Conger's success with analogies did not prevent him from becoming mired in religious-flavored speculations that, if nothing else, showed that the theory still had not fallen into the hands of determinists. And like other users of the idea, Conger seldom endowed his microcosms with a crucial property: motion. With Conger, even living creatures became dry and lifeless. A promising approach ended up a mere catalog of isolated objects.

It need not be that way, for besides their material existence, microcosms are always in motion, the essence of their relationship with their surroundings. By emphasizing these motions we can exhume the ancient idea of the microcosm and make it the central, unifying concept of the Scientific Worldview.

Definition of the Microcosm

A *microcosm*, as I define it, is a portion of the universe. All things are microcosms, because all things, by definition, are matter and all things are portions of the universe. A microcosm, like a system, can be anything that anyone says it is. The boundaries of a microcosm, just like those of a system, are arbitrary, although they must be carefully defined. Their purpose is to focus our attention and to aid in communication.

The whole point of this chapter is to illustrate how extremely important is the process of achieving this focus. In the conventional, system-oriented approach, scientific studies generally concern only the relationships within the boundaries of the system under consideration. Relationships that extend outside the system are assumed by definition to be insignificant and are ignored. This is precisely what we want to avoid.

In earlier chapters I referred to microcosms in some of the traditional ways. In addition to the word *system*, I used *thing*, *body*, *object*, and *particle* whenever I wanted to refer in general to a portion of the universe. There are, however, numerous objections to the continued use of the last four terms in a general theory. A major one involves their usual association with passivity and internal simplicity—hallmarks of classical mechanism. When applied to what appears to be a simple portion of the universe they may be acceptable, but when applied to what appears to be a complex portion of the universe they are not. Human beings, for instance, are portions of the universe, but few of them wish to be considered things, bodies, objects, or particles. By default, these terms overemphasize the external as much as *system* overemphasizes the internal. For our purpose they are archaic. They smack of atomism and fatalism.

Each of the mechanical terms simplifies the subject matter in a different way. When I speak of the "particle" that is irritating my eye, I am purposely ignoring its finer details—its crystal and atomic structure is of no importance to me. In a similar way, physicists who hypothesize a fundamental unit of matter quite naturally call it an ultimate "particle," not an ultimate "system" or ultimate "microcosm." As mentioned, the Newtonian abstraction emphasized the motions and interactions of "bodies," mostly ignoring the internal workings of these portions of the universe.

Today's system-oriented abstraction, on the other hand, emphasizes the internal workings of microcosms, mostly ignoring the external interactions. Thus, complicated ecological systems, for instance, are seldom thought of as "bodies" even though they are similar in some ways to other "bodies" and are subject to similar laws. Overall, there is a tendency among systems philosophers to forget that all "systems," even ecological ones, must move or evolve in relation to other systems.

To repeat a theme initiated in the discussion of the Ten Assumptions of Science, the main problem with the word *system* involves its connotation as being self-contained, a thing divorced from its environment. Having ideally isolated a system in our imaginations, we tend to believe, incorrectly, that such isolation is possible in reality. Fortunately, we are slowly learning that not only is isolation physically impossible, but the existence of a thing is dependent on the existence of the things in its environment. As David Bohm put it, "No given thing can have a complete autonomy in its mode of being since its basic characteristics must depend on its relationships with other things. The notion of a thing is thus seen to be an abstraction, in which it is *conceptually* separated from its infinite background and substructure."[241]

Regrettably, it seems impossible to patch the system and its environment back together with the old terminology. To achieve the proper focus—a balanced, dialectical treatment of the system and its environment—we require a replacement for the term *system* and the other terms that we have used to direct attention to a portion of the universe.

Surroundings, environment, and other terms designating the universe outside a particular system were not strong enough to prevent the rise of systems philosophy. Surroundings and environments were always secondary; the system was always primary. The term *microcosm*, however, can go a long way toward establishing a proper balance, as we will see below.

Redefinition of the Macrocosm

We need terminology that will virtually demand equal emphasis on systems and environments when we think about them. The first step in this direction was the selection of *microcosm* as a replacement for *system*. This alone was an improvement precisely because microcosms always have been considered parts of something larger, whereas systems have been considered self-contained. The second step is to select a replacement for the weakling, *environment*. This is necessary because if the combination *system-environment* did not stimulate dialectical thinking, then the combination *microcosm-environment* may not do much better. The combination itself should have a dialectical balance. The antonym of *microcosm* is *macrocosm*. The combination *microcosm-macrocosm*, then, is what we want. Microcosm and macrocosm have a semantic similarity and historical association that virtually prevent us from thinking of one without the other.

There is, however, one problem with this attempt to use existing terminology. Macrocosm has been used as a synonym for *universe*. It is rarely used for that purpose anymore, perhaps because its root, *cosmos*, is sufficient for indicating "everything that exists." We can take advantage of this usage gap and redefine *macrocosm* as "that portion of the universe outside of a particular microcosm." To make the suggested usage clear, we write:

microcosm + macrocosm = universe

Thus, under this proposal, *macrocosm* and *universe* cannot be considered synonymous, as is customary. With this redefinition each unique microcosm has its own unique macrocosm, which is defined automatically when the boundaries of the microcosm are specified. The macrocosm is simply everything else.

It is, of course, impossible to consider each and every part of the macrocosm in its relationship to a particular microcosm. An analysis must, of necessity, consider finite elements to be meaningful. In practice, we will continue to use *macrocosm* much like the word *environment*, in which, for example, we might refer to nearby features of the universe and ignore those at a distance that we believe to be insignificant for a particular analysis. As always, we can consider the main features of the microcosm and the main features of the macrocosm. We need not, and indeed cannot, consider many of the lesser ones, because their number is infinite.

Definition of the Univironment

We are well on our way to achieving a new focus, one that will be an alternative to the currently popular system-oriented viewpoint. In moving from the microcosmic toward the macrocosmic we want to make sure, however, that we do not overdo it. An analysis that overemphasizes the macrocosm is no better than one that overemphasizes the microcosm. There is no point in repeating the mistakes of classical mechanism.

Now I would like to introduce a new term that is extremely important because it helps to elucidate and to meld the relationship between microcosm and macrocosm. The new term is *univironment*,[242] which is a combination of the roots of *environment* and the Latin prefix for one. The *univironment* is defined as that combination of the matter in motion within the microcosm and the matter in motion in the macrocosm that is responsible for the motions of the microcosm. Of course, there are other words for the same thing, but in my opinion, none is adequate. Words such as *totality* and *universe* have similar meanings, but these seem to connote "all things in existence" and thus lack any focus whatsoever.

Although the univironmental approach at first appears mere common sense, the struggle to achieve it has been protracted. It is only implicit in the philosophy of dialectical materialism and only emerges occasionally in natural science. With great effort David Bohm, a dialectical thinker and an excellent writer, tried to express that which we now realize as the univironment:

> To see the world from the side of its being a unity, we must start from the notion that the basic reality is the totality of actually existing matter in the process of becoming. It is the basic reality because it has an independent kind of existence such that none of its characteristics depend on anything else that is outside of itself. This is so because the totality of matter in the process of becoming contains, by definition, everything that exists.[243]

Bohm's erudition virtually cries out for the creation of a new word; "The inner character of a thing and its relationships to external causal factors are united in the sense that the two together are what define the causal laws satisfied by that thing."[244]

Even those who normally avoided dialectical thinking have been unable to avoid recognizing the importance of the univironmental relationship. Whyte wrote of the "quasi-dialectical interplay between each structure and its immediate environment; it needs its antagonist if it is to keep repeating itself."[245]

The great Hispanic-American philosopher George Santayana observed that "Everything that exists exists by conjunction with other things on its own plane; it belongs somewhere and to a certain time by virtue of the external relations which pin it there."[246]

A microcosm, then, cannot exist by itself, without its macrocosm. It is the intimate relationship between these two parts of the universe that we try to describe when we speak of the univironment. The term *univironment* should continually serve to remind us of this relationship. To understand the development of a particular microcosm, taken as a whole, we must understand both the matter in motion within and the matter in motion without. While a complete and perfectly balanced knowledge of a univironment is unattainable, such knowledge can remain a conscious goal.

As in the approach of systems philosophy, the boundary between the microcosm and the macrocosm often is only imaginary and must be defined somewhat arbitrarily. The exact placement of the boundary is often less important in the univironmental approach than it is for the system-oriented approach. With systems it is critical. Systems philosophers do not intend to ignore only certain distant, minute, or insignificant portions of the macrocosm; they intend to ignore all of it. As a matter of technique, if systems philosophers think a portion of the macrocosm is important, they redefine the system to include that portion. The purist in systems philosophy thus cannot avoid defining the system as though the rest of the universe does not exist.

For example, a study of the chemical reactions within a malignant cell probably need not concern the effects of such an esoteric and far-removed phenomenon as the solar wind. The solar wind can be considered as one of the significant parts of the macrocosm or not, as the occasion suits us. However, the concept of the univironment forces us to keep an open mind about whether a particular macrocosmic factor is likely to be significant. In the past, if one wanted to consider the solar wind's effects on the instigation of cancer, one would include it within the system by redefining the boundaries of the system. A defect of that approach, however, is that one then assumes this new definition of the system is completely exhaustive. The concept of the univironment, on the contrary, assumes just the opposite—that whatever the definition of the microcosm, only half of the "main features" necessary for its motion are contained within. An equally important half remains outside its boundaries.

Thus, with the univironmental approach the transformation of a body cell from normal to malignant is never considered as purely a result of the internal workings of the cell itself, but as a result of interactions between that cell and its surroundings. Like all microcosms, the cell cannot even exist without its surroundings.

The term *univironment* should be used flexibly, but always in the context of a particular discussion of a particular microcosm. Subjectivity in the use of this or any word, of course, cannot be avoided. The user of the term will have in mind certain "main features" of the univironment that may or may not reflect reality. Others may not necessarily agree that these are the "main features" to be considered. According to *materialism*, the only way to discover the "main features" of a univironment is to test that judgment in the real world.

The Univironmental Perspective

The Theory of the Univironment provides, if nothing else, a semantic framework we can use for viewing the world. The word *microcosm* virtually demands its accompaniment, *macrocosm*. Together, as the *univironment*, microcosm and macrocosm can be used to unite our thoughts in a way prohibited by both classical mechanism and systems philosophy. No longer need we consciously overemphasize either the microcosm or the macrocosm, when what we are really studying is the relationship between the two of them.

Chapter 5

Neomechanics: The Reduction

> In true philosophy one conceives the cause of all natural effects in terms of mechanical motions.[247]

In this chapter, the most abstract of them all, I present the most fundamental way in which the Theory of the Univironment can be described. This is the beginning point from which we will attempt to understand the interactions of microcosms and macrocosms. Although all interactions are infinitely complex, they have at the same time a fundamental character to which they may be reduced for elementary discussion. Some of you may find this chapter less than interesting, if not difficult. I encourage you to make at least a cursory study of it anyway. In these pages, for example, you will find the scientific foundation for rejecting hypotheses involving extrasensory perception and other claims of the paranormal.

For the determinist, all microcosms are matter and all interactions involve the motions of matter. We must be aware, however, that such a reduction is always considered by indeterminists as extreme in the worst sense and generally is resisted with all the means at their disposal. Indeterminists have another goal, one that is equally extreme: the reduction of all things to spirit. The intermixing of determinism and indeterminism usually assures that neither of these extremes is taken seriously. The indeterministic agenda is for the most part hidden, but because it is ever difficult to confront the material world with a spiritualistic reduction, it commonly takes the form of the argument against reduction itself. For this reason I must restate the case for reduction before I present my version.

The Case for Reduction

If things are infinitely complex, then to know anything at all, we must reduce the complex to the simple. Anything we can say about univironmental interactions will be a "reduction," and anything we can add to what has already been said will be an "expansion." Thus all explanations are either reductions or expansions in comparison to other explanations. Sometimes we need to simplify and at other times we need to elaborate. It makes no sense to be opposed in principle to either process.

In an infinite universe no explanation is above criticism for being insufficient. And no one would have use for reductions that lead to grossly erroneous predictions. But that is not what the so-called "antireductionists" seem to have in mind. Some of them, perhaps misguided by ***finity*** and ***certainty***, may be excused for believing that complete descriptions really are possible. Accordingly, anyone who produces anything less is easily labeled a "reductionist." Others, like those prone to attack classification on principle, join the camp of the antireductionists as a sloppy way of objecting to particular reductions—those the antireductionist feels are inappropriate. Slipshod definitions have evolved along with some of the sloppy thinking of the indeterminists. Thus, reductionism has been represented as "the view that effective understanding of a complex system can be achieved only by investigating the properties of its isolated parts."[248]

By this definition, reductionism is just another name for systems philosophy: the study of microcosms without macrocosms. We should oppose this use of the term *reduction*, as well as the philosophy to which it refers. We should not object to "reductionistic hopes"[249] in general, but only to reductionistic hopes promulgated by systems philosophy. For example, later I will discuss the overly microcosmic analysis of the sociobiologists. They overemphasize genes, they neglect culture, and they come to erroneous conclusions about the relationships between people and their environments. We will see that the sociobiologists' theories are incorrect not because they reduce, but because they reduce incorrectly.

So how do we reduce correctly? As alluded to before, the "correctness" of a particular reduction can be decided only through interaction with the external world. Here, antireductionists get succor from the perpetual tension between theory and practice. I can begin to describe a tree and its macrocosm by telling you about it and showing you pictures of it. At some point I will stop, perhaps because I am tired of describing or because all I really have in mind is to predict the direction the tree will fall when I cut it down to build my house. Theorists commonly feel the need to gather more and more information before acting, while practical people commonly do not feel the need to gather any at all. Cutting down trees cannot be done with absolute safety. Each falling is a dangerous experiment with only partially predictable consequences, but to do it we must reduce the infinite complexity of the tree and its infinitely complex environment to a few simple rules for responding to the consequences of our actions. The typical academic bias against reduction verges upon a call to inaction. After all, it is safer to describe trees than to cut them down.

Antireductionists tend to forget that the development of understanding is an evolutionary process. We first learn the alphabet, then words, then sentences, then paragraphs, always referring to the simpler elements with each advance. As noted, we can understand the unfamiliar only in terms of the familiar. To ask for the reverse, as some do,[250] amounts to an absurd demand for words having more characters than the sentences in which they are found. It is a call for parts that are greater than wholes.

Now, this chapter presents an explanation so elementary that it is akin to the alphabet. Why is this necessary when anyone schooled enough to read a book such as this surely must know the scientific alphabet already? It is necessary because, as I have argued previously, even very advanced "scientific" reasoning tends to use a mishmash of determinism and indeterminism—an alphabet derived from two different languages. A few foreign characters may be tolerable, but when there are too many, they produce grotesque theories that fail. We have to go back to the beginning and start over again. Indeterminists resist this process, partly because of what they have invested in developing the compromises involved in current explanations, and partly because of what they find whenever they explore the character of their starting points in relation to the character of the universe. Although perfectionists have trouble distinguishing between goals and means, although the legitimate rejection of systems philosophy has become entwined in indeterministic semantic tricks, and although the antagonism between thought and action contributes to it, the anti-reduction movement is, at bottom, a manifestation of the indeterminist's opposition to the reduction of the world to matter instead of spirit.

Classical Mechanics

The properties of a microcosm can be known only by its interactions with the macrocosm. A variation of this supposition was the basis for the greatest advance known to science: Isaac Newton's mechanics. Following Galileo and others when the Industrial Revolution was just getting underway, Newton almost single-handedly built the "classical" version of science as the study of matter in motion.

Speaking of the relevance of classical mechanics after the advent of his own theory of relativity, Albert Einstein said:

> Let no one suppose, however, that the mighty work of Newton can really be superseded by this or any other theory. His great and lucid ideas will retain their unique significance for all time as the foundation of our whole modern conceptual structure in the sphere of natural philosophy.[251]

We need to study classical mechanics at least briefly to appreciate why it is considered a conceptual structure of such great significance. In this examination we will see Newton's overwhelming preoccupation with reducing myriad detail to its simplest elements. As in the Theory of the Univironment, Newton focused on certain portions of the universe that he considered to be "matter" and described the relations between these portions and other portions as the effects of "motion." Neither Einstein nor anyone else has improved on this aspect of the reduction.

The remainder of Newton's reduction, however, was as quintessentially macrocosmic as the reaction to it (systems philosophy) was microcosmic. In some ways mechanics was simply an elaboration of atomism. Newton's microcosms were "objects" or "bodies" assumed to have these characteristics:

1. They were perfectly rigid.
2. They were perfectly solid.
3. They were perfectly inert.

These assumptions were nothing new and were not actively defended by Newton. Even though most microcosms obviously did not have the above properties, it was widely thought that the fundamental constituents of matter did. Newton's major contribution was to apply mathematics to that vision. Of course, real bodies, microcosms, have properties ranging from nearly inelastic to nearly elastic, from nearly solid to nearly insubstantial, and from nearly inert to nearly dynamic. By taking his cue from the atomists and their notion of the ultimate, finite particle, Newton ignored the insides of his model. He ended up treating only one ideal end member of a continuum. By ignoring and thus ultimately rejecting microcosmic infinity, he could simplify objects, treat them as wholes and ignore the complicating aspects of the interactions of their parts. And even when he found it necessary to invent the calculus, the formal recognition of parts and wholes, he stuck to the view that the whole is equal to the sum of its parts. This was the major failing of Newtonian mechanics. It was a reduction well suited to the mathematical approach, but in hindsight, woefully inadequate for describing the real world. It is unnecessary to study classical mechanics in detail to appreciate its pioneering look at matter and the motion of matter along with its indeterministic preoccupation with the microcosm as a finite unit. To get an understanding of the macrocosmic version of what was once known as the scientific worldview, let us review Newton's three laws of motion.

Newton's First Law of Motion

> Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon.[252]

As discussed in the section on *complementarity*, this is the earliest version of the basic law of the universe. It first makes a very simple statement about the motion of the microcosm, and then, almost as an afterthought, qualifies it by noting the influence of the macrocosm. The First Law is not even as "mechanical" as it could be. Instead of hypothesizing a second body or microcosm as the agent of change, Newton brings in the concept of "force." The word *force*, however, is an anthropomorphism that, in the opinion of at least one philosopher of science,[253] should be banished from the language. In truth, the second microcosm is endowed with no more will or purpose than the first.

Ernst Mach rightly criticized the microcosmic slant of the First Law by saying that nothing can be significantly predicated of a body's motion if the rest of the universe is assumed to vanish. Newton, of course, had in mind the concept of absolute space as a point of reference when he idealized the motion of the body in the first part of his proposition. Today we assume that no microcosm can exist by itself, and slowly we are beginning to realize that no microcosm can even hold together as a body by itself. And as I mentioned under the discussion of *complementarity*, our assumption of *infinity* implies that Newton's First Law needs modification; the word *unless* should be changed to *until.*

Newton's Second Law of Motion

> The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.[254]

Here Newton links causality with mechanics. A cause is related to the alteration of motion; the greater the interaction between microcosm and macrocosm, the greater the effect on the microcosm. Because Newton's method was purely mathematical, it necessarily dealt with finite, ideal bodies. The forces were ideal, exact, "ever proportional," and the result was motion along a *perfectly* straight line. These idealistic notions are characteristic of the now obsolete belief in finite universal causality, which came to distinguish the mechanical view of the world, the philosophy of *mechanism*.

Newton's Third Law of Motion

> To every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.[255]

Not only is the motion of the microcosm changed as a result of its interaction with the macrocosm, but so is the motion of the macrocosm, according to the Third Law. If one body increased the motion of another, then its own motion was decreased in exactly the same amount. In the Newtonian view, these changes occur to each body as a whole and do not require the participation of parts or of *submicrocosms* within. Following in the atomistic vein, Newton's idealization assumes that the internal characteristics of each body are identical and insignificant.

In its heyday, classical mechanics was an indispensable argument in the conflict with indeterminism. Its development accompanied and advanced early versions of what were to be the assumptions of science, and greatly aided the belief that the universe was orderly and understandable. It initiated the view that motion as well as matter was important and predictable. In spite of this, the primitive, now indeterministic idealizations of classical mechanics brought about its downfall as the basis for an adequate natural philosophy.

Today, to be known as a "mechanist" is to be linked with these discredited aspects of the Newtonian program. Still, if one accepts *inseparability*—Hegel's Newtonian-inspired proposition that there can be no matter without motion and no motion without matter—then one is a mechanist of some sort. Any new version of mechanics, however, must be consistent with the scientific assumptions made unavoidable and called for at present. In particular, it must eschew the microscopic finity and macrocosmic bias of the classical construction. In the proposal below, which I call *neomechanics*, I attempt to weave the Ten Assumptions of Science into a presentation that shows what modifications are necessary in our most elementary picture of the things and events of the world.

Neomechanics: Six Interactions between Microcosm and Macrocosm

The univironmental relationship between a microcosm and its macrocosm can be expressed a little more concretely as an interaction between submicrocosms (various portions of the universe *within* the microcosm) and *supermicro-*

cosms (various portions of the universe *outside* the microcosm). We begin to understand the nature of this by reducing the infinite variety of real interactions to one idealized interaction: that of matter with matter. For the Newtonian mechanist, this interaction involved portions of the universe that were filled with "solid matter." For us, it involves portions of the universe that simply contain other portions of the universe. This is a significant step beyond classical mechanics and deserves at least a modest explanation.

The reduction discussed below is important for understanding the Scientific Worldview for the same reason that the Newtonian reduction was necessary for understanding the mechanical worldview. In the most abstract way, it gives us experience in thinking about things and their motions as the real producers of phenomena. In accord with *inseparability*, we offer no explanation that entertains the ideas of motion without matter, matter without motion, or, in this, the age of Einstein, matter *as* motion or motion *as* matter. This way of thinking is extremely powerful because with one stroke we can eliminate the possibility of such "things" as ghosts and spirits, which, it is claimed, do not contain matter and do not act on physical contact. With it, for example, we can eliminate the possibility of extrasensory perception, which, defined literally, hypothesizes the transmission of communications without microcosm-to-microcosm contact.

Materialism insists that all phenomena are the interactions of matter with matter. Newton reduced these interactions to two principal types: acceleration and deceleration. That still holds, but if we view the interacting bits of matter as microcosms instead of atomisms, then four additional interactions are required. Taken together, the six possible interactions between microcosm and macrocosm (Figs. 5-1 to 5-6) constitute the foundation of what I call *neomechanics*. The real interactions from which these abstractions have been derived usually involve all six to varying degrees, but at any moment, one of them usually dominates. The six interactions are:

A. Acceleration

B. Deceleration

C. Absorption of Motion

D. Emission of Motion

E. Absorption of Matter

F. Emission of Matter

Newtonian mechanics is a veritable celebration of the first two interactions: acceleration and deceleration of the microcosm as a whole. Because Newton's microcosms were solid, hard, finite bodies, he could not conceive of the absorption and emission of matter and motion from within those bodies. The contact surfaces on Newton's microcosms were inflexible and impenetrable.

Today we realize that the interface between microcosm and macrocosm is more like an elastic sieve than a solid wall. It selectively admits matter and motion. This sieve-like interface consists of submicrocosms, no two of which are completely identical. No two portions of the interface have identical resistances to other matter in motion. The interface itself is neither perfectly inelastic as Newton supposed, nor is it perfectly elastic. The properties of selectivity and elasticity are not unique. Any part of space, any part of the universe, provides some access and some resistance to other matter and the motion of matter.

An interface may be coincident with a visible structure, as is an eggshell, or it may be invisible, as is the interface between the solar system and the rest of the galaxy. For theoretical purposes we find that an imagined interface is often suitable and sufficient. It incidentally has the advantage of preventing the contents of the enclosed microcosm from being thought of as totally isolated from the rest of the universe. As a reduction based on the theory of the univironment, one of the primary intents of neomechanics is to make it virtually impossible to conceive of a microcosm without a macrocosm. It is thus an outright rejection of the systems philosophy of the twentieth century. It also endeavors to make it virtually impossible to conceive of a microcosm that does not contain other microcosms. It is thus also a rejection of classical mechanism.

As will become more and more evident as we go along, neomechanics is the foundation of a philosophy that strives to be neither microcosmic nor macrocosmic. A valid criticism of this revision of mechanics is the following: you have perhaps removed Newtonian idealism from the microcosm-macrocosm interaction, but you have merely moved it to the level of the submicrocosm. This is true. In the reduction to follow, submicrocosms and supermicrocosms—the individual parts of the microcosm and the macrocosm—are, at some point, unavoidably treated as rigid, Newtonian bodies. It is true that at some point we must ignore the non-Newtonian interactions (C through F) between submicrocosms, but, as it turns out, this is of no particular consequence to the explanation. We can always include the absorption and emission of matter and motion as factors when the focus is on *them*, as microcosms. According to *infinity*, we are left with no choice; we would have to ignore the internal and external motions of at least some parts of the universe to devise an explanation which, to be expressed, must be finite. As pointed out before, all good scientists must disregard portions of the universe. With neomechanics we analyze what we believe to be the "main features" of the microcosm and the "main features" of the macrocosm in relation to each other. We purposely ignore parts of the microcosm and parts of the macrocosm, not forcing ourselves to ignore either *all* of the microcosm or *all* of the macrocosm.

Similarly, one could question the nature of *contact*, in the neomechanical view. With Newton, the rigidity of the interacting bodies left little doubt in the minds of the idealistically inclined as to the nature of the contact. The contact point was clearly the place where the two bodies met. The motion was transferred from whole body to whole body and submicrocosms had nothing to do with the transfer. In neomechanics, on the other hand, the motion is transferred from submicrocosm to submicrocosm and from subsubmicrocosm to subsubmicrocosm, and so on. This view provokes some questions: When does this transfer end and why? What really *is* contact? Unfortunately, like all questions involving infinite progressions, these can have no satisfactory answer. One could say that there is not enough "time" for the infinite progression to proceed through an infinity of microcosms within microcosms, but this again would be begging the question. With *causality*, we assume an infinite quality to the cause-effect relationship. It is appropriate that neomechanics include this quality at the same point where cause becomes effect in the Newtonian view. The following are short descriptions of the six possible interactions that occur between the microcosm and the macrocosm.

In the descriptions below the primary focus is on the univironment: the microcosm and the macrocosm considered equally. As mentioned, however, we consider both the microcosm and the macrocosm as infinitely subdividable. Again, the divided portions of the microcosm I call *submicrocosms*, and the divided portions of the macrocosm I call *supermicrocosms*. The prefixes to these terms are not intended to imply any special characteristics other than of position relative to the boundary between the microcosm and the macrocosm.

Type A: Acceleration

When a microcosm is hit by a supermicrocosm, it gains motion (Fig. 5-1). In the ideal model, the microcosm as a whole is accelerated. In classical mechanics the walls of the microcosm are considered perfectly inelastic; an acceleration of the wall at the point of impact produces an "instantaneous" acceleration of the opposite wall as well as all that "solid" matter in between. To the degree that the impact is not in a perfectly straight line, some of the acceleration causes the microcosm to rotate.

In neomechanics, however, some elasticity is required in the walls of the microcosm in order for it to be accelerated at all. In this view, acceleration results from the displacement of submicrocosms at the point of contact. The motion of the supermicrocosm is transferred from supermicrocosm to submicrocosm and from submicrocosm to submicrocosm, accelerating each along what would have been the approximate path of the supermicrocosm had there been no contact.

Example

To illustrate the neomechanical view of type A interactions, let us consider the acceleration of a railroad train. In this example we view the train as a microcosm and the individual cars as submicrocosms. When the end car is pushed from behind by another train (a supermicrocosm), it subsequently collides with the car in front of it. This, in turn, collides with the next, and so on, until the entire train is moving. Motion of the macrocosm is transferred to submicrocosms, which becomes motion of the microcosm as a whole.

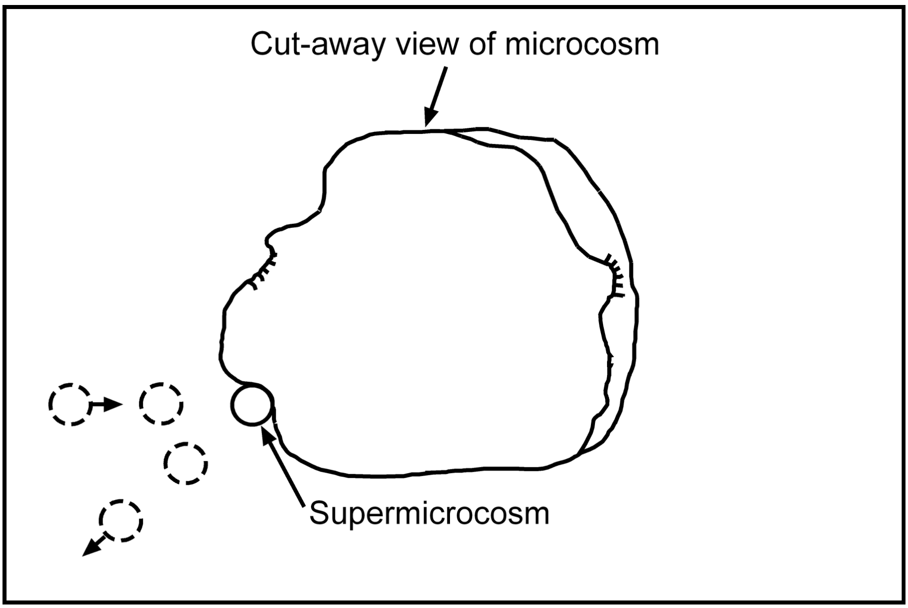


Fig. 5-1. Type A interaction: Acceleration of the microcosm. A relatively high velocity supermicrocosm (external microcosm) collides with and transfers motion to a relatively low velocity microcosm.

Type B: Deceleration

When a microcosm hits a supermicrocosm, it loses motion (Fig. 5-2). The microcosm as a whole is decelerated. Again, this change in motion can be viewed in the classical way in which the trailing edge of the perfectly inelastic body is decelerated at exactly the same time as the leading edge. Or it can be viewed in the neomechanical way, in which the deceleration is transferred from submicrocosm to submicrocosm, with a slight delay in deceleration of the trailing edge. The microcosm is compressed in the direction of travel and is slowed down or decelerated as a whole. To the degree that the impact is not in a perfectly straight line, some of the deceleration causes the microcosm to rotate.

Example

A train is decelerated in the opposite way it is accelerated. The change in motion is transferred from car to car, with an inevitable—though temporary—shortening of the train being the result.

It is unlikely that a person steeped in classical mechanics would choose a train as the best elementary example of type A and B interactions. A Newtonian purist probably would choose a single car instead, trying to convince the reader that the car moves as a whole, that the front moves at *exactly* the same time as the rear. In the neomechanical view, it does not.

Neomechanics requires submicrocosms to transfer motion from one portion of the microcosm to another. The Newtonian view ignores submicrocosms or assumes they are in perfect contact, which amounts to the same thing. This is why the Newtonian model must be one of an "ultimate" particle, the atom filled with an indivisible substance through which motion can be transferred perfectly and instantaneously. Our adoption of the Theory of the Univironment goes "beyond Newton" because it forces us to admit that the acceleration and deceleration of the microcosm requires internal interactions. We must conclude that the transfer of motion from microcosm to microcosm does not occur in the perfect way assumed by Newton. As a result, there are losses; the transfer of motion cannot be 100 percent efficient. Some of the motion of the whole appears as motion of the parts, leading to interactions that Newton did not consider: the absorption and emission of motion, the essence of the *closed system* of today's parlance.

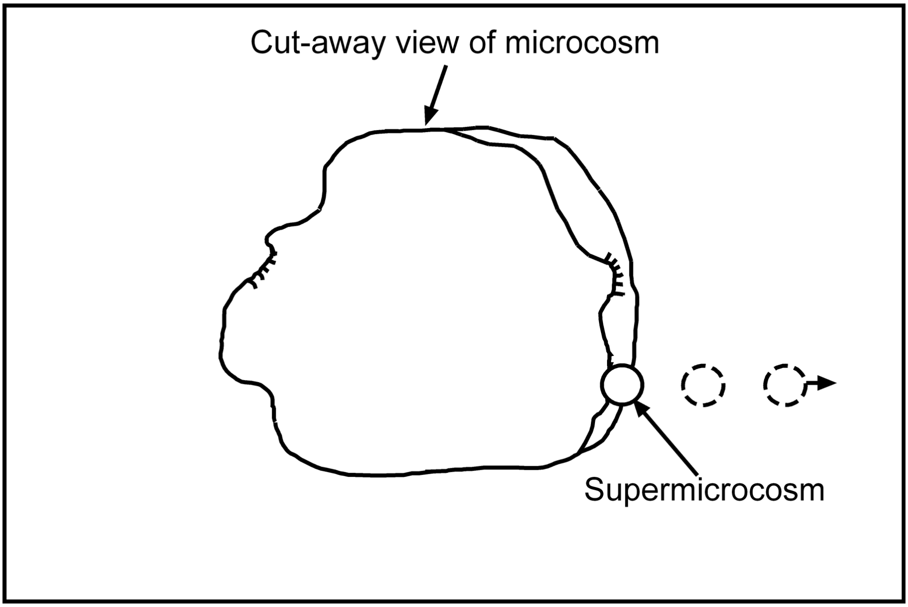


Fig. 5-2. Type B interaction: Deceleration of the microcosm. The microcosm collides with and transfers motion to a low velocity supermicrocosm.

Type C: Absorption of Motion

All microcosms have submicrocosms through which the motion of impacting supermicrocosms is transferred. The motion of acceleration or deceleration is, in effect, temporarily absorbed. It does not instantaneously appear as a change in motion of the microcosm as a whole. Sometimes, the impact against the univironmental interface barely changes the motion of the microcosm as a whole. In such cases, the motion of impact is absorbed by submicrocosms as internal motion.

When supermicrocosms hit the microcosm, the elasticity of the interface allows motion to be transferred to the submicrocosms within (Fig. 5-3). The submicrocosms are speeded up, and we say that the microcosm has gained internal "energy" (or enthalpy, H, in the lexicon of thermodynamics). This increased internal motion is measured as an increase in mass.[256] For example, a hot teakettle has more internal motion and weighs more than a cold one. The molecules within move more rapidly in a hot kettle than they do in a cold one. This means that any small volume within the microcosm of the kettle then has more submicrocosms of a certain type moving through it per unit time. There is a slight decrease in entropy as well as a slight increase in density, which is a measure of the number of submicrocosms per unit volume. The above examples are idealizations. In reality, they describe only tendencies. Not all of the motion of a converging supermicrocosm can be absorbed internally. For one thing, the submicrocosms are not as free roaming as depicted for the ideal model (Fig. 5-3). As mentioned under Type A interactions, some of the motion of the supermicrocosm is transferred from submicrocosm to submicrocosm in the general direction in which the supermicrocosm had been traveling. Submicrocosms to one side of this path tend to be accelerated less than those near the path. In a way, the submicrocosms along the path tend to move as a unit, or as a whole. This is precisely the type of motion we idealized for type A interactions in which the microcosm as a whole was accelerated.

All real impacts from supermicrocosms produce both acceleration and absorption of motion. Acceleration and absorption models are idealized, nonexistent end members of a continuum, which Newton reduced to one end member: acceleration. Because his model had no submicrocosms, he neglected the absorption part of the continuum.

There are a few additional important details concerning the absorption of motion. In the treatment above, we assumed a microcosm of constant volume, but no real microcosm could have a perfectly inelastic interface for maintaining a constant volume. Thus, after the impact of the supermicrocosm, the increased internal motions of the submicrocosms are likely to impact the interior surface of the interface with greater momenta, pushing it outward toward the macrocosm. In short, there will be a tendency for the volume to increase—for the microcosm to expand. The motions of the submicrocosms are then spread over a larger volume, the density decreases, and entropy increases as the submicrocosms diverge from each other. In addition, it is possible for internally absorbed motion to appear as rotational motion of both the submicrocosms and the microcosm as a whole.

Example

The Type C interaction, in which motion is absorbed by the microcosm, is illustrated by the interaction between the hammer and the nail. The microcosm of the nail is accelerated by the supermicrocosm of the hammer, but if the wood is especially hard, the nail absorbs much of this motion instead. The submicrocosms within the microcosm of the nail are accelerated and the nail becomes hot. Instead of appearing as motion of the whole, most of the transferred motion appears as motion of the parts.

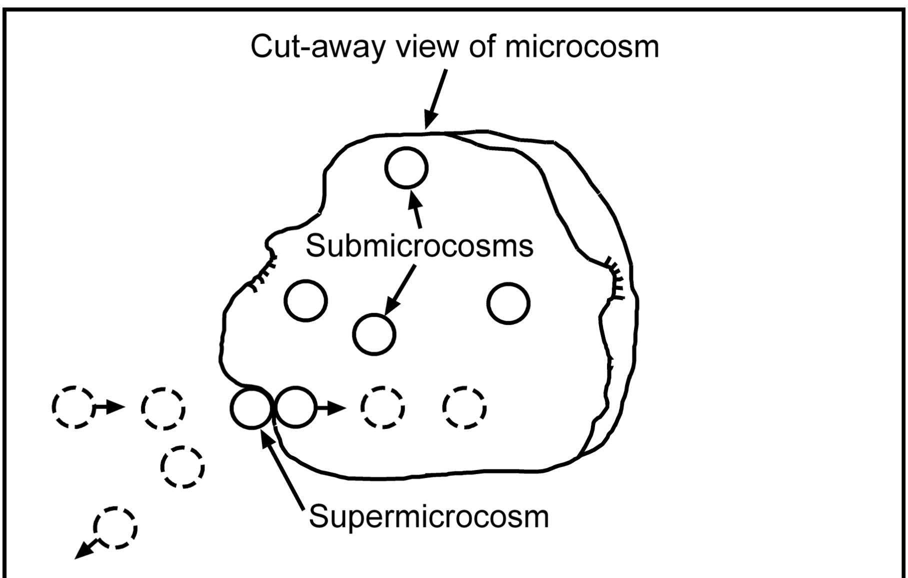


Fig. 5-3. Type C interaction: Absorption of motion. A supermicrocosm collides with and transfers motion to a low velocity submicrocosm (internal microcosm).

Type D: Emission of Motion

The emission of motion (Fig. 5-4) is the opposite of the absorption of motion. Emission occurs when a rapidly moving submicrocosm collides with a slower supermicrocosm. This transfer of motion results primarily in a deceleration of the submicrocosm rather than of the microcosm as a whole. The increased motion of the supermicrocosm can appear either as the acceleration of the supermicrocosm as a whole, or as the increased motion of submicrocosms within the supermicrocosm.

If absorption of motion increases the momenta of the submicrocosms within the microcosm, then emission of motion decreases them. Mass and density decrease and entropy increases as a result of the emission. And because there will now be fewer impacts on the interior of the univironmental interface, the volume will tend to decrease. This secondary reaction increases mass and density and decreases entropy, offsetting some of the effects produced by the initial reaction. Of course, it is also possible for rotational motion of submicrocosms and of the microcosm as a whole to be lost through emission.

Example

Emission is complicated, but a simple example illustrates its principal results. Consider what happens when cold water is dropped on a hot frying pan. The microcosm of the hot frying pan has within it submicrocosms, atoms, that have rapid vibratory motion. Upon contact, some of this motion is transferred to the more slowly vibrating submicrocosms of water molecules within the supermicrocosm of the water droplet. The water molecules absorb the motion emitted by the hot frying pan. The internal motion of the submicrocosms within the droplet increases—the temperature rises. Some of this submicrocosmic motion appears as an acceleration of the supermicrocosm as a whole. We observe this as the tendency for the droplet to assume a spherical shape and, if the frying pan is hot enough, to actually leave the surface, propelled by the extremely rapid motions of the vapor that forms beneath it.

Because motion and matter are inseparable aspects of a single reality, the next two interactions are actually special cases of type C and D interactions, only this time the interactions involve only matter, the essence of the *open system* of today's parlance. The effects of the absorption of matter or motion are similar. Both, for example, are convergences, and thus both result in increases in mass and density, and decreases in entropy. Although it is a minimal aspect of type E and F interactions, matter cannot be absorbed or emitted without accelerating or decelerating the microcosm as a whole.

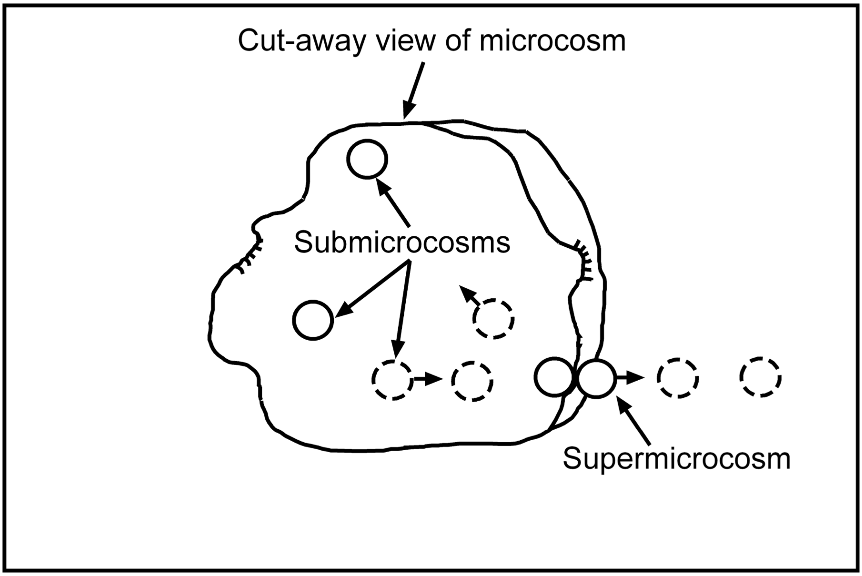


Fig. 5-4. Type D interaction: Emission of motion. A submicrocosm collides with and transfers motion to a low velocity supermicrocosm.

Type E: Absorption of Matter

The sieve-like character of the interface between the microcosm and the macrocosm allows a converging supermicrocosm of an appropriate size and velocity to penetrate the interface and enter the larger microcosm (Fig. 5-5). This addition of a smaller microcosm to a larger one results in a net increase in mass and, to the extent that the volume of the microcosm does not increase, results in an increase in density and a decrease in entropy as well.

Example

All microcosms have openings that allow matter to enter from the macrocosm. The filling of a container with water is a good illustration of the absorption of matter. The small size of the supermicrocosm of the water allows it to enter the microcosm of the container when there is a convergence between water and container. In addition, the microcosm of the water accelerates the microcosm of the container slightly, while the water becomes decelerated, remaining inside the container.

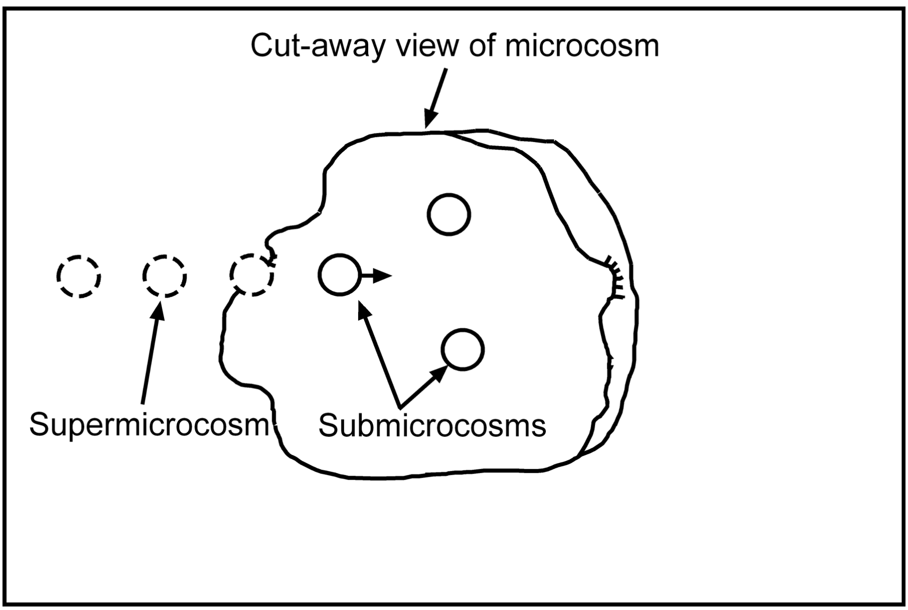


Fig. 5-5. Type E interaction: Absorption of matter. A supermicrocosm enters a low velocity microcosm and becomes a submicrocosm.

Type F: Emission of Matter

The same characteristics of the interface that allow the absorption of supermicrocosms may also allow the emission of submicrocosms (Fig. 5-6). The submicrocosms within a microcosm have their own inertial motions that result in their continual bombardment of the interface. Thus under certain conditions, a submicrocosm may break through the interface and leave the microcosm under its own inertial motion. In this regard, it is indeed unfortunate that the available terms for describing this process, such as *emit*, *eject*, and *release*, have teleological connotations that fail to emphasize the inertial aspects of this motion

The effects of the emission of matter are just the opposite of its absorption. The mass decreases, and to the extent that the volume of the microcosm does not decrease, there is a decrease in density and an increase in entropy as well. There will be some decrease in volume because, with fewer submicrocosms to impact on the interior of the interface, the macrocosm, with its continual bombardment of the interface, will encroach on the microcosm.

Example

The emptying of a container of water is an example of the emission of matter. For this to occur, the motion of the submicrocosm of the water must be greater than the microcosm of the container that holds it. This relative difference in motion, coupled with the presence of a suitable opening, produces the divergence from the microcosm, which amounts to a decrease in entropy. It is this type of interaction we celebrate in the classical demonstration of the Second Law of Thermodynamics (Fig. 3-1).

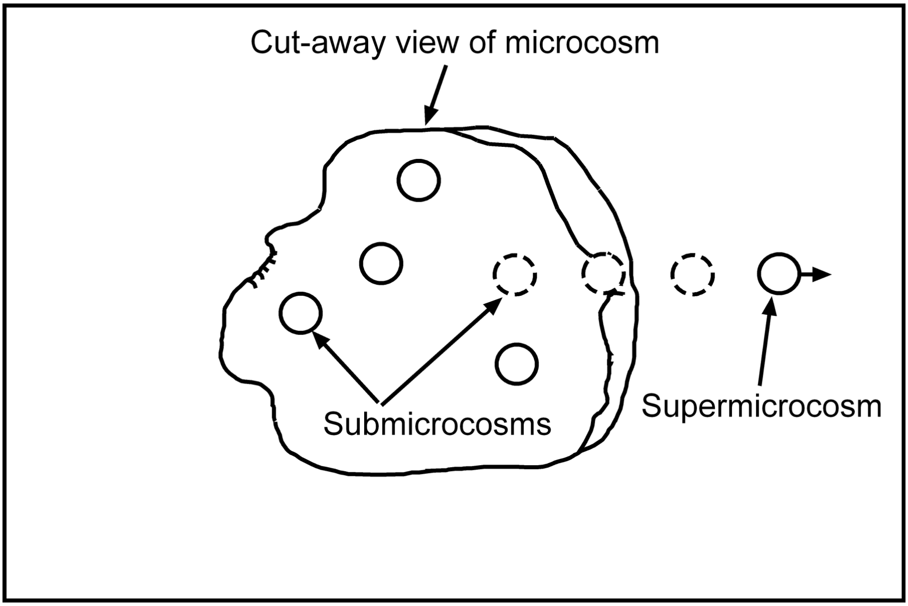


Fig. 5-6. Type F interaction: Emission of matter. A submicrocosm leaves a low velocity microcosm and becomes a supermicrocosm.

In reality, the six ideal interactions described here are never found in pure form. Any actual interaction between microcosm and macrocosm must involve all six interactions to varying degrees. Thus, a converging supermicrocosm: 1) accelerates the microcosm as a whole, 2) produces absorption of motion internally, and 3) penetrates the microcosmic boundary, at least temporarily adding some of its matter to the microcosm. And, as Newton observed but stated in a different form, the microcosm and macrocosm undergo equal and opposite reactions. Thus, a converging supermicrocosm: 4) decelerates, 5) emits some of its internal motion, and 6) loses matter to the microcosm. Univironmental interactions are inherently dialectical. There can be no acceleration of the microcosm without a corresponding deceleration of the macrocosm, and there can be no absorption of motion or matter within the microcosm without a corresponding emission of motion or matter from the macrocosm. The microcosm and the macrocosm undergo equal and opposite irreversible reactions. Not only are their momenta and space-time positions changed as a whole, but the momenta and space-time positions of their contained submicrocosms and supermicrocosms are changed as well. An interaction between the microcosm and the macrocosm irreversibly changes both.

We must always remember that these neomechanical idealizations of univironmental interactions are, for the most part, gross oversimplifications. In reality, each microcosm undergoes an infinite number of these interactions with the macrocosm at every moment. The interactions, in fact, are what define the microcosm. Without the differences in the motions of matter on either side of the univironmental boundary, we could not discern a microcosm at all. We would have no reality on which to base our imagined model, which by comparison is a mere cartoon. The neomechanical reduction nevertheless assimilates some very powerful assumptions requiring a considerable revamping of conventional scientific explanations. For instance, you may have noted that this scheme requires no "attractive force." It does not treat motion or time as a fourth dimension of material objects. The expansion of one portion of the universe invariably occurs at the expense of other portions of the universe. Because neomechanics assumes *infinity*, the concept of an expanding universe makes no sense at all.

Striking at the heart of systems philosophy, neomechanics reminds us that microcosms are neither perfectly isolated nor perfectly nonisolated. When we imagine them to be nonisolated, the decrease in entropy resulting from the inevitable convergence coming from the macrocosm is just as "spontaneous" as the increase in entropy undergone by supposed isolated systems as their parts diverge into the macrocosm. All microcosms at all times are increasing or decreasing in mass, velocity, density, volume, entropy, and apparent order. At times the motion of matter within the microcosm is such that the macrocosm yields on nearly all fronts—the microcosm expands. At other times the motion of matter within the microcosm is less and the macrocosm pushes in from nearly all sides—the microcosm contracts. The macrocosm yields to a certain extent and resists to a certain extent. This univironmental relationship determines the spatial extent of the microcosm. Since all things either converge on or diverge from other things at all times, the interface between the microcosm and the macrocosm moves back and forth. Like a beating heart, the microcosm pulsates with the macrocosm, expanding and contracting. The spacetime position of the univironmental boundary is determined neither by the microcosm nor by the macrocosm, but by both in a reciprocal relationship.

Each microcosm moves through the macrocosm in whatever direction that yields to it. This it does until, inevitably, it reaches a part of the macrocosm where the resistance, the motion of matter, is comparable to that of the microcosm. The microcosm is slowed, its motions becoming more like those of the macrocosm. Momentarily, the microcosm and the macrocosm display an approximate unity, a sort of ephemeral truce along the univironmental border. Such a microcosm has moved toward *univironmental equilibrium*, the subject of the next section.

Univironmental Equilibrium

All microcosms at all times move toward *univironmental equilibrium*. In neomechanics, equilibrium clearly refers to the dynamics of the univironment, the relationship between microcosm and macrocosm. A *stable* univironment is one in which the motions of the microcosm and the motions of the macrocosm are similar; an *unstable* univironment is one in which the motions of the microcosm and the motions of the macrocosm are dissimilar. Stability and instability are ideal end members of a continuum. Like the related ideal concepts of absolute rest and absolute motion, neither can exist in reality.

As explained under *inseparability* and *complementarity*, one of the failings of systems philosophy is its frequent ambiguity regarding the referent in discussions of stability and equilibrium. Systems often are said to be "stable" or "unstable," as though stability could be a system property. The error often arises through a conceptual confusion of system boundaries and subsystem boundaries. Thus, two parts of a system may be in relative equilibrium with respect to each other. One part, considered as a microcosm, is stable relative to the other part considered as a macrocosm, and vice versa. This correct observation concerning the two parts of the system is then mistakenly attributed to the system taken as a whole. The true referent, the macrocosm, disappears in a way worthy of the subtlest solipsism. In spite of its many anthropocentric concepts, such as force and attraction, classical mechanics availed scientists of a generally objective image of the world. The inertia concept, for example, did not require an answer to why things moved in the first place. Once in motion relative to other things, Newtonian objects continued to move—*unless* they collided with other things. The results of these collisions, in turn, could be considered independent of a willing agent. And as long as the mechanists concerned themselves only with inanimate matter, the question of goal or purpose remained in the background.

Nevertheless, the naturalistic image courted by the Newtonian reduction encouraged attempts to discover an equally naturalistic explanation for goal-oriented behavior. The first of these was formulated by P. L. M. de Maupertuis as the Principle of Least Action.[257] Based on the Newtonian tradition, the Principle of Least Action emphasized the acceleration and deceleration of whole bodies. Focusing on one of two bodies, it stressed that when a high-velocity body overtakes and collides with another, it always slows down as a result. Similarly, a body never speeds up on its own. Thus, the motion or "action" of a body either remains constant or tends to decrease—as long as it travels through "empty space" or encounters only slower bodies. The principle was reintroduced in the nineteenth century by W. R. Hamilton and even was extrapolated to sociology in the twentieth century by G. K. Zipf.[258]

The demise of classical mechanism also led to the decline in popularity of the Principle of Least Action. Today, naturalistic explanations of goal-oriented behavior generally rely instead on the Second Law of Thermodynamics (SLT), interpreted, of course, from the viewpoint of systems philosophy. The problems with that approach were discussed in the section on *complementarity*. The Principle of Least Action was born with similar problems.

Actually, the distinction between classical mechanism and systems philosophy was never as great as I generally have so far portrayed it. The underpinnings of systems philosophy have been with us since the utterance of the first anthropocentrism. In astronomy, for instance, the Ptolemaic system was nothing if not microcosmic. As implied before, the traditional orientation was even built into Newton's First Law. A body was said to travel in a straight line *unless* it encountered another body, not *until* it encountered one. Being derived from the First Law, the Principle of Least Action carried with it the seed of systems philosophy and its antidialectical concentration on the *collider* rather than the *collidee*. Rapidly moving bodies inevitably were slowed down when they collided with other bodies and thus the colliders always tended toward *least* action. Nevertheless, other mechanists could not avoid seeing that moving bodies inevitably were speeded up when faster-moving bodies hit them. Collidees invariably exhibited *most* action rather than *least* action as their "goal"—a phenomenon wreaking as much confusion in classical mechanism as it does today in systems philosophy. The Newtonian penchant for considering space as absolutely fixed and for considering the first body as primary and inevitable and the second as secondary and optional provided the excuse for choosing least action rather than most action as the goal toward which things supposedly were headed. Of course, relative to the motions of surrounding bodies, the actual motions of all real bodies range between rapid and slow. Like the SLT, which succeeded it, the Principle of Least Action was useful only for bodies whose motions were rapid relative to their surroundings; that is, they had to be relatively isolated from their surroundings. Without a certain ignorance of the macrocosm, the Principle of Least Action was worthless.

A truly deterministic explanation of goal-oriented behavior could be discovered only from the univironmental point of view. Newton was moving in this direction when he admitted the possible existence of the second body in his First Law of Motion. Of course, depending on which of the two colliding bodies one focused, action after contact could be either at a minimum or at a maximum. Even though special relativity implied that there was no basis on which to choose between these two possibilities, tradition continued to favor the Newtonian bias.

From the systems point of view, there was a convenient way all interactions could be made to fit the Principle of Least Action. Whenever the "action" of a body was observed to increase instead of decrease as a result of a particular interaction, one could simply expand the boundaries of the system so as to include the impacting body. When this was done and the rest of the macrocosm was ignored, the amount of action after the impact would still be minimal and the rule would be preserved. As we have seen, this is the approach used in current interpretations of the Second Law of Thermodynamics—minus the mechanical imagery. In the end, both the Principle of Least Action and the SLT apply only to such ideally isolated systems and say nothing whatever about the macrocosm. The Principle of Least Action was replaced by the SLT partly because Least Action furnished an inadequate view of the microcosm in spite of its microcosmic focus. Following Newtonian tradition, its microcosms tended to be platonic forms—wholes without parts. Accordingly, the principle ignored the absorption and emission of matter and motion. The objects of concern were finite and therefore the causes of the motions of these objects were considered finite too.

With neomechanics, on the other hand, we stress that each of the wholes (microcosms) contains within it an infinite number of parts (submicrocosms), and each has outside of it an infinite number of interacting parts (supermicrocosms). Because neomechanics is based on infinite universal causality *(Causality)*, the *cause* of each motion must be considered infinite too. With the Theory of the Univironment, we explicitly acknowledge this dialectical interplay between the infinite microcosm and the infinite macrocosm. Both the microcosm and the macrocosm contribute equally to the motions of the microcosm. The microcosm moves through the macrocosm under its own inertial motion, but it does so only to the degree that the macrocosm does not resist this motion. In the univironmental view, the relative resistance of the macrocosm is no less important than the relative inertia of the microcosm.

By studying the univironmental relationship, we try to predict the motions of the microcosm. The possibility of prediction arises because we know that rapid motions within the macrocosm produce rapid motions in the microcosm and vice versa. Similarly, slow motions in one produce slow motions in the other. Thus, these motions tend to become similar on either side of the univironmental boundary. The upshot is that, at all times, the microcosm approaches an equilibrium with its macrocosm; that is, it moves toward *univironmental equilibrium*.

Univironmental equilibrium, thus, is the "goal" toward which all behavior is directed. Behavior in general is *not* directed toward least action or most action or toward the most entropy or the least entropy. Instead, the direction of movement of the microcosm is determined in each instance by the relationship between the matter in motion within and without. The microcosmically oriented laws devised by classical mechanism—as well as systems philosophy—apply only to ideally isolated microcosms; they claim nothing whatever about ideally nonisolated microcosms. But as mentioned under *complementarity*, real microcosms exist throughout the range between these two ideals. Isolation reflects the passivity of a particular macrocosm, while nonisolation reflects its activity. Thus a microcosm surrounded by a passive macrocosm exhibits "least action" and increasing entropy as its apparent "goal," while a microcosm surrounded by an active macrocosm exhibits "most action" and decreasing entropy as its apparent "goal."

It has long been known that the concept of equilibrium pertains to the fundamental characteristics of the universe. The question arises as to why the word *univironmental* must be appended to the word *equilibrium*. Remember that systems philosophy, by definition, views equilibrium as something "in the system." For the modern indeterminist, equilibrium is, at most, a balance between two parts of a system. But as soon as we view equilibrium as a relationship between microcosm and macrocosm, we leave systems philosophy and indeterminism behind. It is true that when equilibrium is defined properly, the appending of *univironmental* is merely redundant. Until then, however, the combination of *univironmental* and *equilibrium* serves to remind us of the proper focus.

When we say that a particular microcosm is moving toward univironmental equilibrium, there should be no doubt that it is headed for the type of motion that results from the motions of the infinite parts within and the infinite parts without. The nature of the interaction of microcosm and macrocosm is dependent on only two things: the nature of the microcosm and the nature of the macrocosm. This line of thinking leads to another important consequence in regard to the interpretation of *causality*. With both the microcosm and the macrocosm containing an infinite number of submicrocosms and supermicrocosms, and with the degree of passivity as well as the degree of activity contributing to the result, we must assume that *exactly half of the "cause" of a particular interaction lies within the microcosm and half lies within the macrocosm*.

The general tendency of microcosms to move toward univironmental equilibrium may be seen wherever we look. Take, for example, the motion of an automobile in heavy traffic. The "microcosm" of the auto entering the fast lane moves toward "univironmental equilibrium" by accelerating to the speed of the vehicles in the surrounding "macrocosm." As long as the vehicle ahead and the one behind travel at velocities similar to that of the microcosm of the auto, no collisions between vehicles will occur. The motions within the microcosm and those within the macrocosm are such that the microcosm of the auto has achieved temporary univironmental equilibrium. This situation changes as soon as a change in velocity occurs in the microcosm (the auto) or in the macrocosm (the vehicle ahead or the one behind). The microcosm will be speeded up if it is impacted from the rear or slowed down if it collides with the vehicle ahead. That either of these events does not happen more often than it does is, of course, dependent on the motions within the univironment in a complex way.

Impending collisions are routinely avoided as a result of the reciprocal relationship between microcosm and macrocosm. The driver within the microcosm of the auto may take corrective action to achieve univironmental equilibrium, which normally means the avoidance of an accident. Even if the driver of the microcosm of the auto uses bad judgment, all may not be lost, for the drivers within the macrocosm still may react to this "incorrect" motion in an appropriate way. A change in motion within the microcosm results in a change in motion in the macrocosm and vice versa. A fast microcosm within a slow macrocosm soon becomes a slower microcosm. A slow microcosm within a fast macrocosm soon becomes a faster microcosm.

Gas molecules also undergo motions that demonstrate the tendency for microcosms to move toward univironmental equilibrium. As seen in the demonstration of the Second Law of Thermodynamics, the microcosm of the gas-filled chamber loses gas molecules to the macrocosm of the empty chamber when the valve between them is opened (Fig. 3-3). In the absence of suitable material constraints within the macrocosm, the inertial motion of the gas molecules carries them to the region of lesser density of matter of that type. In every case, the motions of matter within the microcosm become more in tune with those of the macrocosm, but in so doing the macrocosm is unavoidably and irreversibly changed as well.

Infinity and Perpetual Motion

It must not be thought that the microcosm and the macrocosm could ever achieve some sort of permanent univironmental equilibrium. This clearly would be impossible because the univironment contains an infinite number of things in constant motion and most are not involved in any particular interaction. Submicrocosms, being themselves infinitely varied, converge on and diverge from each other, continually evolving new types of combinations and new types of dissolutions that eventually disrupt the equilibrium from the inside. Supermicrocosms undergo similarly irreversible reactions, producing new combinations and dissolutions that eventually disrupt the equilibrium from the outside.

In coming to grips with *causality*, *uncertainty*, *relativism*, and *infinity*, neomechanics provides an extremely simple, but potentially rich, abstraction that allows us to view things not as isolated objects, but as microcosms that are parts of univironments. Admittedly, neomechanics is a mere cartoon of reality. Nevertheless, like the best of cartoons, it has the merit of placing things in the proper context. The motion of microcosms can no longer be viewed as a property of microcosms alone, but as a property of the univironment. Motion is a relation between the microcosm and the macrocosm.

Chapter 6

Univironmental Determinism: The Expansion

Logically, in some obscure manner, cosmic and biological evolution are one.[259]

With neomechanics we looked at the Theory of the Univironment in its most reduced form. As with all fundamental reductions, the images produced are bare skeletons of reality. They may provide a clear foundation, but they are useless without the fleshing out that comes with further interaction with the external world. All practice immediately produces the need for an expansion in theory. The more of its naturally infinite detail that we can include in our thinking about a particular microcosm and its macrocosm—the greater the expansion of our model of reality—the more accurate our predictions of its motion will be.

Even the most detailed expansion, however, need not abandon either the univironmental focus from which it begins or the mechanism by which it predicts. No amount of sophistication justifies or requires hypotheses contrary to the Ten Assumptions of Science. From physics to psychology, we need not yield to the indeterminist's propensity, for example, to propose *spirit* (defined as motion without matter) as a necessary part of a proper expansion. As critics of classical mechanism have pointed out, the need for expansion increases with the complexity of the things we study. Thus the life sciences in particular require an expansion involving much more than the image afforded by converging and diverging spheres. Nevertheless, by considering living things as microcosms, their irreversible movements toward univironmental equilibrium take on a significance missing from classical mechanism. In reaching out for an expansion of its knowledge about even the most complex things, humanity was forced to view them in context. And since things and their contexts had infinite qualities, they were infinitely changing. The more one looked at things and events in a univironmental way, the more one was led to the idea of evolution.

Although the philosophical struggle has limited the expansion of knowledge and restricted the idea of evolution, there nevertheless emerges a pattern to the myriad motions we see all about us. Each microcosm fills a unique space-time position. That is, at any moment each microcosm has a unique relationship to all other things in the universe. Each microcosm moves through the macrocosm, always moving toward temporary univironmental equilibrium. Each microcosm comes into existence as supermicrocosms converge; each passes away as submicrocosms diverge. In an infinite universe, these motions of the microcosm constitute process, and process is evolution.

At the same time that it deals with specific submicrocosms and supermicrocosms, the greatest expansion on the Theory of the Univironment must be cognizant of the infinity within and without. At the extreme in classical mechanism, the microcosm, in effect, had no submicrocosms. The Newtonian body was internally the same after an interaction as it was before the interaction—there was no internal motion, no evolution of the microcosm. At the extreme in systems philosophy the macrocosm, in effect, had no supermicrocosms. The environment of a system was the same after an interaction as it was before the interaction—there was no external motion, no evolution within the macrocosm. Even though both the macrocosmic and the microcosmic approaches claimed to be scientific, each in its own way evaded assumptions that would have made it more deterministic and closer to reality.

The earliest attempts to view the world as matter instead of spirit developed a similar limitation. Matter got the existence, but spirit got the motion. Materialists acceded to such ***separability*** well into the nineteenth century. And then, as soon as matter could be thought of as being everywhere in motion, the philosophy of matter was forced to yield to the philosophy of motion. The primary philosophical question switched from "Why do things exist?" to "Why do events occur?" In reality, of course, existence could not be separated from occurrence. The appropriate question really was, "Why do things exist and do what they do?" The query of existence had to be, at the same time, the query of occurrence. In the previous chapter we discovered that all microcosms move toward univironmental equilibrium. This was little more than common sense; *What a thing is and what it will become is determined by the matter in motion inside it and* *the matter in motion outside it*. Nevertheless, this discovery is of great philosophical import. When combined with *materialism*, *inseparability*, *infinity*, and the other Assumptions of Science, the tendency of microcosms to move toward univironmental equilibrium must be viewed as a restatement of evolution and of determinism: *Univironmental Determinism*.

In Univironmental Determinism, philosophy and the mechanism of evolution become one. In this unification, the guiding proposition of philosophy and the guiding proposition of evolution are identical. As the philosophy, Univironmental Determinism replaces classical mechanism and modern systems philosophy; as the mechanism of evolution, it replaces natural selection and neo-Darwinism.

The rest of this chapter presents a short history of previous mechanisms of evolution with emphasis on their limitations and relations to philosophy, an example of evolution by means of Univironmental Determinism, and some solutions to problems inadequately explained by neo-Darwinism.

History of the Mechanism of Evolution

Evolution produces its own discoverers. The universe inevitably and periodically contains within it matter that contemplates itself. The concepts of progress, change, and evolution grow along with thinking beings as they evolve from nonthinking matter.

For our planet, the idea of evolution was first expressed in Western thought in the fifth century BC by Anaxogoras, the Greek philosopher who proposed one "Mind" as the unifying "substance."[260] In Eastern thought the idea was expressed as an overall organizing principle (Tao) that supposedly transcended the material (Chi). The microcosmic and transcendental focus has been enduring. At the turn of the century, even the distinguished evolutionist Ernst Haeckel, the first ecologist, would write, "The *atom* is not without a rudimentary form of sensation and will, or, as it is better expressed, of feeling and inclination—that is, a universal 'soul' of the simplest character."[261]

In the early part of the twentieth century, philosopher A. N. Whitehead would write in a serious discussion on evolution, "The soul cries aloud for release into change."[262] And later, scientist-philosopher Pierre Teilhard de Chardin, too, would insist that man was driven by the "restlessness of his soul."[263] Although overt references to "mind" or "soul" as the mechanism of evolution are now scientifically unacceptable, the microcosmic viewpoint that engendered them lives on.

Scientific attempts to discover the mechanism of evolution were largely confined to the discipline of biology. In 1809 Chevalier de Lamarck, a French naturalist, suggested that evolution occurred through the appearance of new traits in response to usage; usage in response to need; and need as a consequence of physical surroundings. This excellent, much-maligned suggestion, however, erred in one important respect: timing. Lamarck attempted to boost his case by claiming that acquired traits could be inherited within the first generation. In the classical example, Lamarck explained that, in straining for scarce food supplies in the uppermost branches of trees, giraffes stretched their neck muscles. Once stretched, a long neck somehow would be passed on to the offspring. Lamarck was, of course, unaware of the contribution of genes, which were to be discovered much later as the microcosmic agents involved in a much less dynamic and much more complex evolutionary scheme. Even though the Lamarckian mechanism of evolution had to be rejected, it succeeded in drawing biologists away from the microcosmic preoccupations of indeterministic philosophy.

In 1859 Charles Darwin proposed natural selection as the mechanism of evolution. No other mechanism could have been more macrocosmic, for like the mechanical philosophy from which it was derived, natural selection saw the object of concern at the mercy of its surroundings. In Darwin, the reciprocal relationship between microcosm and macrocosm was even less recognizable than in Lamarck. Perhaps for that reason, natural selection became an almost overnight success. By saying little about the microcosm itself, Darwin left a place of refuge for indeterministic speculation. Aristotelians could push their acausal interpretation of the "random" variation found in all organisms, while vitalists, the creationists of that time, could grow a full-fledged movement.

The Darwinian compromise nevertheless exposed it to criticisms such as this one: "Natural selection (is) an evolutionary factor capable of initiating nothing, dependent … on some primary factor or factors controlling the origin and direction of variation. It seems better to go back to the old and safe Ignoramus standpoint."[264] Natural selection still begged questions. Why was there anything to select from in the first place? What is the source of the variation between individuals?

Such questions, although often motivated from a desire to defeat the atheism implied in natural selection, highlighted the major weakness of the mechanistic approach Darwin had used. His initial overemphasis on the macrocosm was so blatant that, as an afterthought, Darwin himself eventually strove to treat the insides of his model. His rectification was *pangenesis*, the hypothesis that body cells throw off particles that circulate throughout the system, multiply by subdivision, and then collect in the reproductive cells.[265] There was little evidence for this and the hypothesis was never taken seriously.

In 1900, scientific attention returned to the microcosm when Gregor Mendel's outstanding work on genetics was rediscovered. In combination, genetics and natural selection eventually became the accepted mechanism of evolution, commonly referred to as *neo-Darwinism*. The success of neo-Darwinism in advancing biological science in the twentieth century cannot be doubted. In the general consideration of evolution it overshadowed all other proposals, especially those in the nonbiological sciences. The concepts of natural selection, genetics, and evolution became so entwined that for a scientist or creationist to think of evolution in less specific terms became an onerous chore. To this day, the debate between evolution and creation has remained mired in biology.

Neo-Darwinism was not meant to be, nor could it be, a general mechanism of evolution. With its rise, the prospects dimmed for a theory of evolution that would involve all microcosms, not just the biological. Like a castle on a hill, this narrow-minded approach to evolution was the easiest to defend. Darwin himself did not consider natural selection to be all-inclusive; "Variations neither useful nor injurious would not be affected by natural selection."[266] Supposedly, some parts of the biological kingdom were affected by it and some were not.

Modern scientists of wide experience and varying philosophical background have honored the ambiguity ever since: "Conceivably, optical activity in biochemistry is the result of natural selection."[267] The confusion has even found its way into the prestigious and widely read journal *Science*: "An adaptive trait is one that has arisen by evolution and so has a genetic base."[268] Even in the late twentieth century, readers had to be excused for wondering what other kinds of traits might exist and how they might arise through means other than evolution

The neo-Darwinian model tends to reduce the infinite complexity of the microcosm to its genetic component. Conceptually, all the stuff of the biological microcosm gets crammed into that remarkable entity: the gene. Other submicrocosms get slighted and at the extreme, we are left with visions of prancing, "selfish" genes swilling at the trough of life.[269]

By overemphasizing the gene's contribution, neo-Darwinists unwittingly have become the enemies of the idea of evolution. Anyone who rigidly believes that genes are absolutely necessary for evolution is unlikely to believe that *all* things evolve. Biology congratulates itself on having achieved the "Modern Synthesis." Few neo-Darwinists see anything wrong with the overspecialized nature of their guiding paradigm. After all, they are biologists—the rest of us don't count. Current debate in evolutionary theory is a mop up exercise that typically concerns such bogus questions as whether evolution is always slow or always rapid.[270] Biology seems incapable of producing a truly general theory of evolution.

Neo-Darwinism must be junked. It can never be more than a special, inadequate case of the general mechanism of evolution. Throughout the sciences it is becoming increasingly obvious that evolution is not confined to biology. We know that stars evolve. Do stars have genes? We know that chemical elements evolve. Do elements have genes? We know that landscapes evolve. Do landscapes have genes? In classic understatement, Theodosius Dobzhansky, a major contributor to neo-Darwinism, once said, "Nothing in biology makes sense except in the light of evolution."[271] Does *anything* make sense except in the light of evolution? Isn't it about time that we had a more general mechanism of evolution, one that applies to all microcosms?

Univironmental Determinism: The New Mechanism of Evolution

In its most reduced form, the Theory of the Univironment became neomechanics; in its most expanded form it becomes the mechanism of evolution. This new mechanism, *Univironmental Determinism*, simply states that *the evolution of a microcosm is dependent on the motions of matter within and without*. This evolution, this motion of the microcosm, is in all cases in only one direction, toward univironmental equilibrium. Being derived from *causality*, the assumption that there are an infinite number of causes for all effects, there can be no greater generalization to be made concerning the mechanism of evolution.

As the all-inclusive mechanism for everything that happens in the universe, Univironmental Determinism offers the grandiose expansion for which antireductionists have always clamored. Unfortunately, like the reality from which it is derived, the infinite complexity of Univironmental Determinism is surely more than any such indeterminist may have bargained for. The dreamed-of finite universe does not exist, and its supposed potential for complete explanation will never be realized. The infinitude of the universe makes us all reductionists in practice.

In our finite fallibility, we can, at the most, draw attention to a few of what we believe to be the *main features* of both the microcosm and the macrocosm. The scientific method, guided by Univironmental Determinism, then becomes *univironmental analysis*, in which we consciously attempt to strike a balance between our consideration of the internal and the external. If we are to have a truly scientific worldview, we must abandon the macrocosmic preoccupations of classical mechanism and the microcosmic preoccupations of systems philosophy.

In the next chapter, univironmental analysis will be explained in detail. For now, I use it to demonstrate Univironmental Determinism as the mechanism of evolution. In the hypothetical example below I follow tradition by using a biological model as the starting point. The explanation is greatly simplified and the details are not accurate perhaps, but the comprehensiveness of the mechanism and the point of view should become clear. Be prepared to shift univironmental boundaries quickly from microcosm to microcosm, from atoms to cells, to organs, to individuals, to groups, to species, to ecosystems, and back again. Even though this example is a biological one, the emphasis is on space-time positions instead of genes and their mutation or other peculiar aspects of the biological microcosm. The example sets the stage for examining other problems in evolution and for viewing Univironmental Determinism as the mechanism of evolution in nonbiological systems.

Evolution of the Giraffe's Neck via Univironmental Determinism

In 1977 a neo-Darwinist reiterated the popular claim that "in the unremitting confrontation between a species and its environment, it is not the animals *as a group* upon which selective pressures act, it is the *individual* animal that is the so-called unit of selection."[272] It is this myopic, rather typical opinion[273] that I wish to dispel with the proposal that Univironmental Determinism is the mechanism of evolution. With this new generalization the "unit of selection" becomes the microcosm, *any* portion of the universe we care to define. Above all, this includes groups as well as individuals or parts of individuals. There is no magical boundary, biological or otherwise, that must be used. No portion of the universe escapes evolution.

If we grant that each portion of the universe is continually evolving, then it makes no difference where we start an explanation of evolution. To emphasize this point I therefore make a choice that may appear somewhat startling: I choose the giraffe's neck as the "unit of selection." After all, if neo-Darwinians can attribute selfishness to genes, why can't we attribute selfishness to necks? If neo-Darwinians can envision prancing genes, why can't we envision prancing necks? These notions are offered only half in jest. Contemplating the neck as the "unit of selection" might at first seem rather strange, even ridiculous, but actually, it goes right to the crux of the problem. It has certain advantages for making my point. By viewing the neck as a microcosm, we are continually forced to admit its dependence on the macrocosm, which so obviously includes the head and the body. We cannot grant the neck its "selfishness" without also granting its "cooperation" with the rest of the animal.

This story of neck evolution begins millions of years ago in northern India with *Samotherium*, an early ancestral giraffe that had a short neck and fed on grassland much like a horse or cow. One could ask: why start with *Samotherium*? Why not start with some other microcosm, the "real beginning," and thus provide a "complete" illustration of evolution? According to *infinity* and *causality*, however, this would require an infinitely long explanation. *Infinity* allows us to start wherever we wish. It may as well be with *Samotherium*.

Every *Samotherium* had a neck of unique length. According to *interconnection* and *relativism*, necks, like everything else, are parts of the universal continuum. No two necks are identical, and we need not bring in genetics to explain this fact. *Infinity* will do it for us. A particular neck has a certain length because its univironment was once unstable enough to produce it and is now stable enough for its continued existence. The long-lived or "stable" necks will be found in long-lived or "stable" macrocosms. Relatively stable necks will be attached to relatively stable bodies and these, in turn, will be parts of relatively stable herds and relatively stable species that are parts of relatively stable ecosystems and so on.

But nothing lasts forever; submicrocosms within the microcosm and supermicrocosms within the macrocosm always are in motion relative to each other. Changes in the macrocosm affect the microcosm and vice versa. A blade of grass eaten yesterday cannot be eaten again today. In *Samotherium* country, the condition of the range, an important feature of the macrocosm of the species, is constantly changing. Plentiful rainfall may produce an abundance of grassland vegetation, an expansion of an important part of the *Samotherium's* macrocosm. This, in turn, leads to improvements in the condition of the microcosm of the species dependent on it. This univironmental relationship insures that the condition of a species is constantly changing—it is never the same for two successive moments. Each species has a unique relationship with its food supply at all times.

Necks, too, reflect this relationship. When food is abundant, the microcosm of the neck grows sleek and fat, its bones and muscles strengthen—the neck expands. When food is scarce, the microcosm of the neck grows ragged and thin, its bones and muscles weaken—the neck contracts. This occurs to all necks regardless of their associated genetic makeup.

Of course, the expansion or contraction of the microcosm of a particular neck depends on an infinite number of factors other than food supply. It obviously depends on the nature of the head and the body to which it is attached—the organs through which the food supply is realized. And, surely, it depends on the nature of the microcosm of the neck itself. As the vital link between head and body, it contains within it submicrocosms necessary for its own existence and, not coincidently, for that of its surroundings. When the motions of the neck are of a certain character, the head and the body prosper. When the motions are of another character, the head and the body suffer. An improved or diminished capacity of the macrocosm of the head and the body cannot fail to improve or diminish the capacity of the microcosm of the neck. The relations between the neck and its mutually supporting organs are clearly reciprocal; each affects the other. The microcosm changes the macrocosm and the macrocosm changes the microcosm.

The microcosm of the neck moves through the macrocosm, producing a unique history. Its irreversible motions delineate ever-changing space-time positions that define its existence. One day it is part of an animal standing next to a tree; the very next day it is part of the same animal standing next to the same tree. Its position relative to the tree may be nearly identical on different days, but its *space-time* position is not. Both the microcosm and the macrocosm have changed during the intervening twenty-four hours.

The neck expands from a tiny microcosm, taking in supermicrocosms and receiving motion from the macrocosm, expanding toward limits controlled by the univironment. The history of each microcosm, of each neck, is unique. Each affects the macrocosm in different ways. Some histories are relatively long and involved; some are relatively short and simple, but all have an impact on what is to follow. The sensitivity of the microcosm of the neck is total. Its every motion is an evolutionary motion.

In the transition from the short-necked *Samotherium* to the long-necked giraffe, the univironment of the short-necked progenitor forced a gradual change in diet from grass to leaves. As mentioned, the food supply is always increasing or decreasing. The macrocosm is always in motion; some plants are growing and expanding while others are dying and contracting. Abundance and scarcity alternate in progressive cycles. For the grass-eating progenitor of the giraffe, each famine was both a disaster and a challenge. Each contraction of the macrocosm resulted in a contraction of the microcosm of the species. But no two portions of a microcosm are identical. Within the microcosm of the *Samotherium* species there existed many varieties. One of these, of course, lived nearer the forest than the others. The macrocosm of this variety contained a potential food source that was to become more and more attractive whenever the grassland deteriorated.

The microcosm of the edge-dwelling variety contained within it submicrocosms—herds of varying character. Some herds, perhaps those spending much time in the forested areas, grew especially accustomed to the sight of tree leaves. Familiarity bred analogy. Indeed, some members of these herds eventually ate tree leaves as well as grass leaves. For *Samotherium*, a new food supply was born.

The benefits of the new diet were at first barely significant. The choice between browsing and grazing was not necessarily one of life and death. But the individuals and the herds that turned to browsing when grass was scarce were in slightly better condition during those periods than the grazers. The microcosm of the browsers expanded in comparison to the microcosm of the grazers. For a short time, the quantity and quality of *Samotherium* life improved for those who turned to tree leaves for food.

When the grassland returned to verdancy it was only natural that many of the browsing *Samotherium* would revert to their former habits. But the effects of that episode of browsing were irreversible. The submicrocosm of former browsers, since they had more and healthier descendents, comprised a greater portion of the microcosm of the *Samotherium* species. And when the grasslands once again deteriorated, the descendents of the former browsers still comprised a unique microcosm. This microcosm was different, not only because of what was inside it, but because of its place in the macrocosm. When the browsing episode was over, *Samotherium* left for the lush grasslands, traveling in all directions from the groves of trees that had been salvation for so many. These travels halted just as soon as the *Samotherium* encountered an abundance of easily harvested food. At first sight, it appears that this regression in neck evolution was total, but a second look shows the macrocosm of former browsers to be different from that of the other grazers. For one thing, the emergency diet was closer.

With each turn of the grassland food cycle, the *Samotherium* variety living near the forest was inclined to eat tree leaves as an emergency measure. But the woodland also had a cycle of scarcity and abundance, and sometimes it coincided with the grassland cycle. Starvation was common to *Samotherium* in both woodlands and grasslands. For enfeebled animals, moving from one to the other produced only detriment. Famine caused the microcosm of browsing *Samotherium* to contract, but not all portions of it contracted to the same degree. At this time, neck length became a particularly important characteristic of the microcosm of individual animals. With neither the grassland nor the woodland shrubs providing sufficient sustenance, a long neck became extremely important.

As mentioned, within the microcosm of browsing *Samotherium* there existed necks of varying length—no two were exactly alike. Those with long necks survived in slightly better condition and lived slightly longer than their short-necked relatives. As always, the quality of life was better for some than for others. Well-nourished animals reproduced at faster rates than those poorly nourished, and so the submicrocosm of browsing *Samotherium* with long necks was accompanied by greater numbers of healthy offspring than the submicrocosm with short necks. As we know, eventually this variety of *Samotherium* switched almost entirely from grazing to browsing.

To find out why, we need to evaluate the microcosm of the *Samotherium* in more detail. One of these details—genetic mutation—is usually introduced by neo-Darwinians much earlier in their explanations of evolution. The delay here emphasizes that it is submicrocosmic variation in general and not just a particular kind of submicrocosmic variation that is crucial to evolution. Evolution would occur even if genes did not exist. Genes are important because, in biological microcosms, they are part of the material connection between old microcosms and new microcosms. Let us explore how this connection is made.

As mentioned, the microcosm of the neck responds to conditions within the macrocosm, growing strong and healthy when a strong and healthy body supplies its needs. A strong, healthy neck, in turn, performs its functions well, aiding the body in a reciprocal, “cooperative” arrangement. This aspect of neck existence extends throughout the macrocosm, particularly to the other organs of the *Samotherium* body. Of course, it extends to one important link with the future:

reproduction. As mentioned, when under stress, browsing *Samotherium* with long necks were in slightly better condition and had slightly better rates of reproduction than those with short necks. The length of the neck obviously influenced which animals reproduced successfully and which did not.

Neck length would make no difference in the characteristics of the offspring if reproduction for all animals was identical, but it is not. According to *relativism*, no two *gametes*, the reproductive cells of the parents, can be identical. The genes contained within these gametes, likewise, vary from one to the other. Each gene has its own history and develops characteristics that reflect its interactions with the macrocosm.

When these interactions result in microcosmic changes we call them *mutations*: physicochemical alterations of the gene. The alterations can be produced in myriad ways, with cosmic radiation being one of the most important influences. Each gene as well as each cell of the body undergoes a unique radiation history that produces structural changes. In reproductive cells these changes sometimes are realized in the somatic cells of the offspring. Most radiation, however, produces only minor, undetectable changes in genes that only occasionally result in somatic changes in the offspring.

The most vulgar way of explaining the evolution of the giraffe's neck would be to hypothesize a "random" mutation resulting in the birth of an individual with a long neck. Then, through natural selection, we could show how this individual lives to pass the gene for long necks to future generations, and let it go at that. Although mutations producing such great changes are perhaps not impossible, they are extremely unlikely. Certainly our experience with billions of domestic animals rarely includes single-generation mutations for long necks. The use of "catastrophic mutation" to explain evolution is as overly microcosmic as Lamarckism is overly macrocosmic.

There probably are hundreds, if not thousands, of genes influencing neck length. The gene exerts important control through its influence on the manufacture of hormones and other chemicals. Nevertheless, the impact of this influence is always limited. If the macrocosm of the gene is of a certain type, the impact may be insignificant; if it is of another type the impact may be great. One thing is sure: unless the macrocosm benefits in some way, the existence of the gene will be cut short.

An obvious way in which genes benefit their surroundings is by improving the health and condition of the bodies in which they exist. Univironmental equilibrium in such cases means that genes of a certain type produce bodies of a certain type, and these in turn produce offspring of a certain type. But the influence of a gene is not limited merely to the body in which it exists or even to its offspring. We must remember that, like all microcosms, the influence of the gene extends to the macrocosm: all that is outside of it. Thus the effect of a single gene for hemophilia, for instance, has been wide ranging. It has influenced the personal relationships of unrelated individuals. It has been known to influence international diplomacy.

On the other hand, the effect of a particular gene on the development of the offspring is by no means total, as is sometimes implied by neo-Darwinists. For example, the length of the microcosm of the neck is controlled by what is outside it as well as by what is inside it. The microcosm of the neck consists of millions of bone cells, each a tiny submicrocosm whose size and properties also are determined, in turn, by its microcosm and macrocosm. If that univironment includes a certain amount of calcium, a certain amount of phosphate, and certain amounts of all the other necessary ingredients, the bone cell will be a certain size. A change in the quantity of any of these ingredients may result in a smaller or larger bone cell.

Thus if a small amount of "extra" calcium was added to the macrocosm of the cell during its development, this would present a condition not normally encountered. As always, such a change in the macrocosm results in a subsequent change in the microcosm toward univironmental equilibrium. The resulting cell is always different from what it would have been had no additional calcium converged on it from the macrocosm. Added calcium results in the diffusion of additional phosphate toward this cell and the precipitation of additional hydroxyapatite. This serves to remind us that a bone cell thus may grow somewhat larger than normal, independent of the direct influence of genetic factors.

The microcosm of the enlarged bone cell may benefit the macrocosm, producing a more stable, healthier body that exists for a longer time than it would otherwise. The body, in turn, influences its macrocosm to a greater extent than it would otherwise. Some of these macrocosmic influences may include the transmittance of genes for long necks. The upshot is that the existence of a long neck has aided the existence of genes for a long neck and vice versa. In this case, the macrocosm of the soma and the microcosm of the gene exist in a reciprocal, cooperative relationship.

Always, there are vital connections between the microcosm and the macrocosm. For example, the microcosm of an individual animal contains sensory systems that become active (unstable) when the animal is hungry. An empty stomach sets off a chain of chemical reactions affecting numerous complicated submicrocosms. The animal becomes aware of hunger through chemical reactions in the central nervous system that activate still other submicrocosms involving sight, smell, and so on. These are the windows, so to speak, between the microcosm of the animal and the macrocosm of its surroundings. Sense data from the macrocosm is then processed by the nervous system through millions of reactions, each proceeding toward univironmental equilibrium.

Decisions are reactions based on information stored in the brain and nervous system. Ideas forming at different times or in different brains may seem identical, but like the reactions from which they stem, they are not. These reactions, too, are simply the motions of microcosms, no two of which are identical. Each decision is the motion of matter toward a univironmental equilibrium unique in space-time.

A particular neck and all its descendant necks move toward univironmental equilibrium amid constantly changing univironments. Gradually, through thousands of generations, the necks of *Samotherium* interacted with the macrocosm in ways in which the macrocosm changed them and they changed the macrocosm. Minute changes in genetic material resulted in minute changes in somatic material, and vice versa. These in turn changed the macrocosm of the animal, family, herd, variety, species, and ecosystem. The evolution of the giraffe's neck involved all these interrelationships, not just one or even a few.

The neck on a live *Samotherium* is just as much in equilibrium with its univironment as the neck on a dead one. The two necks simply represent two different forms of the existence of matter in motion. At death, the neck ceases its major contribution to the *Samotherium* world. The submicrocosms of which it is composed begin a new existence, contributing to evolution in a radically different way.

Relatively stable necks, of course, generally are attached to animals whose longevity is aided by the character of their necks. Taken as a whole, the univironments of these animals are made relatively stable by their possession of relatively stable necks. Neck length, of course, is only one of an infinity of characteristics that are passed on to subsequent generations. The significance of each of these characters also changes with each passing moment.

Every footstep of every ancestor of the giraffe was an evolutionary step. Each motion was a contribution to the whole. Univironmental Determinism, the tendency for all microcosms to move toward univironmental equilibrium, pushes each microcosm forward to a destiny determined by the motion of matter within and without.

New Solutions to Problems in Evolution

Not only is neo-Darwinism of no help in explaining inorganic evolution, its limited view is deficient in biological evolution as well. Its failures are especially obvious in semipopular interpretations of the theory. In preparing their accommodations with scientific theories, indeterminists search for any weakness that might conform to their preconceived notions. Neo-Darwinism fails to answer the simplest of questions.

What Controls Evolution?

Once again, Univironmental Determinism states that all microcosms are controlled by the univironment: the motions of matter within and without. Neo-Darwinism states that genes within and some things without control biological microcosms. Not being all-inclusive, neo-Darwinism typically allows for other than deterministic possibilities. The mystical, still widely revered neo-Darwinist Chardin presented one of the best-known exploitations of this opening. Familiarity with genetics and natural selection did not prevent him from proposing what might be called the "anarchy theory of life."

> But whereas in the case of so-called inert matter the increase in volume soon reaches a point of equilibrium, no such limit appears to be set to the expansion of living substance. The more the phenomenon of cellular division spreads, the more it gains in virulence. Once fission has started, nothing from within can arrest its devouring and creative conflagration, because it is spontaneous. Nor is there any external influence powerful enough to check the process.[274]

The logic of this was impeccable: if the origin of the conflagration had no material cause, then its ending could not have one either. Chardin was not one to shirk tough questions. Getting right to the point of it all, he once asked, "How can life respect determinism on the *without* and yet act in freedom *within*?"[275] But as an indeterminist, he would never answer that question. He could only complain "biology has not yet found a way of reconciling … the spontaneous activity of individuals with the blind determinism of the genes."[276] Like the vitalists and systems philosophers in general, Chardin looked for the answer only within the microcosm; "life can build itself up chemically."[277] For Chardin, the macrocosm played an insignificant part in the biological mystery; life became cause, never effect.

As mentioned, the control exerted by natural selection was seen by Darwinists and neo-Darwinists alike as only occasional. Following this path to an extreme, the conservative neo-Darwinist Garrett Hardin proposed that there is "always an appreciable probability that evolution may go counter to natural selection, that the population may naturally become less fit."[278]

Like other idealists, Hardin thought he knew fitness when he saw it. When his idea of fitness appeared in jeopardy, he attacked the supposed mechanism by which fitness was produced. Natural selection yielded to this subjective insult. Luckily, we have been spared a full-fledged theory of "counter natural selection" to fill the neo-Darwinian gap. What controls evolution? Neo-Darwinists may be the last to know.

What is the Point of Biological Activity?

With Univironmental Determinism, all activity is evolutionary activity produced by the motions of matter in the univironment. With neo-Darwinism, the primary reasons for biological activity remain obscure. For instance, Shklovskii and Sagan asked, "Can it be that reproduction is in some sense the 'point' of biological activity? Is it really … to ensure the continual existence of the molecules of our genetic material; a sense in which we are fundamentally ambulatory repositories for our nucleic acids?"[279] Or can we generalize a bit more, with Melvin Calvin, that the "chief business of any living thing is survival?"[280]

To answer such questions, one must carefully distinguish between the general and the specific. Biological activity is more general than reproduction, ambulation, or survival. General questions obviously require general answers. Neo-Darwinism may have a great deal to say about reproduction and survival, but it becomes severely strained even when it is applied to ambulation. Neo-Darwinism cannot answer questions concerning biological activity in general because it clearly is no match for the task.

According to Univironmental Determinism, biological activity occurs not simply because genes exist, but because biological microcosms exist. And like all other microcosms they must move at all times toward univironmental equilibrium. Sometimes activity results in reproduction, sometimes ambulation, and sometimes survival, but these are only a few of the infinite number of possibilities. To squeeze all that complexity into one or several special categories simply vulgarizes the great cosmic drama of matter in motion.

Does a Fixed Environment Cause Struggle?

Neo-Darwinians tend to ignore the main show: motion. Miller and Miller,[281] for instance, were able to write a large text on evolution with barely a mention of the stability-instability concept. It should be clear that instability (movement, reaction, struggle) results from changes, instabilities, in the univironment. As mentioned previously, increased motion within the macrocosm results in increased motion in the microcosm; decreased motion of the macrocosm results in decreased motion in the microcosm. Without this elementary perspective, neo-Darwinism is prone to simple mistakes. At one extreme, a relatively stable macrocosm is said by philosopher Whitehead to produce instability within the microcosm: "To a large extent the environment is fixed, and to this extent there is struggle for existence."[282] At the other extreme, a relatively stable macrocosm is said to produce *perfect* stability within the microcosm; "some organisms, like foraminifera survived all geological ages *without participating in evolution*, a point of perplexity in the theory of natural selection."[283]

The environment that Whitehead sees as fixed is really a macrocosm containing supermicrocosms whose motions either cause or allow the motions within the microcosm to appear as struggle. A "slow" macrocosm produces a "slow" microcosm. A perfectly fixed environment would be motionless and could contain only motionless systems—no struggle whatsoever. Such environments and such systems only exist in the heads of idealists. Catastrophist Immanuel Velikovsky, more than Whitehead, realized this, even though he went on to confuse the ideal with the real. The environment that Velikovsky saw as fixed is really only *relatively* stable and the foraminifera in this environment remain only *relatively* unchanged as a consequence. Minor changes within the macrocosm result in minor changes within the microcosm, but it is incorrect to hypothesize *zero* changes in the univironment and thereby dismiss evolution altogether.

What is the Cause of Extinction?

To understand extinction, it is absolutely essential to approach the subject from the univironmental point of view. Here, too, neo-Darwinism lacks rigor and clarity. For instance, by using the traditionally narrow definition of fitness, Velikovsky was able to sling the following stones against natural selection:

> These species (camels, horses, ground sloths, musk-oxen, mammoths, sabertooth tigers, and dire wolves of North America) are believed to have been destroyed to the last specimen in the closing Ice Age. Animals, strong and vigorous, suddenly died out without leaving a survivor. The end came, not in the course of the struggle for existence with the survival of the fittest. Fit and unfit, and mostly fit, old and young, with sharp teeth, with strong muscles, with fleet legs, with plenty of food around, all perished.[284]

The Darwinian conception of natural selection pretty much restricts the mechanism of evolution to the biological realm. Other motions of the macrocosm escape inclusion in the notion of fitness, and when this happens, extinction becomes inexplicable in terms of evolution. This leaves ample opportunity for the indeterministic speculations of a Velikovsky.

With Univironmental Determinism, all motions of the macrocosm are candidates for contribution to the evolution of a particular microcosm. Extinction is then seen as a consequence of changes, either within the microcosm or the macrocosm. The upshot is that the motions of the macrocosm become either too rapid or too slow for the continued existence of the microcosm. One may disagree with his divinations concerning interplanetary catastrophes, but Velikovsky is correct in looking toward the macrocosm for the factors responsible for the extinctions at the end of the Ice Age. Most likely, the extinctions were related to the great changes in climate that accompanied the melting of the ice—changes so rapid that sea level rose nearly 100 meters in a few millenia.[285] The more rapidly the macrocosm changes, the more rapidly an organism must respond. If the organism has evolved under relatively unchanging conditions, then it is unlikely to survive a drastic change in the macrocosm.

Many neo-Darwinists, of course, are aware of this fact. For example, J. A. Burton[286] lists climatic and geological catastrophes, as well as direct competition with other species as reasons for extinction. Unfortunately, neo-Darwinian theory does not prevent him from dragging out that old saw "overspecialization" as a cause of extinction. But overspecialization has no meaning except in hindsight. All microcosms are special microcosms in special macrocosms. Overspecialization merely describes a univironmental disequilibrium in which the motions on one side of the univironmental boundary have changed more rapidly than those on the other. Overspecialization, like the concept of stability, thus characterizes the relationship between the microcosm and the macrocosm and cannot be a property of the microcosm alone, as implied by those who use the term most.

There are plenty of examples of what neo-Darwinists might consider overspecialized organisms that demonstrate a hardy resistance to extinction. What could be more specialized than the foraminifera that Velikovsky claimed to be exempt from evolution? For two hundred million years these special creatures have met the minuscule changes of their special environments with only minuscule responses. They survive, not because they are specialized or generalized, but because they are sufficiently in tune with their environments.

Still other neo-Darwinists mistakenly believe that resistance to extinction depends on genetic diversity.[287] One could make just as good a case for genetic homogeneity. Foraminifera, once again, are genetically homogeneous because they live in a relatively unchanging environment. So-called "genetically diverse" individuals appearing in such an environment are quickly extinguished. In this and other neo-Darwinian attempts to explain extinction, the most important concept in evolution typically is slighted: the relation between the microcosm and the macrocosm.

Why Does Evolution Produce Complexity?

Without the assumption of *complementarity*, the answer to this question remains forever elusive. J. A. Riegel, a typical neo-Darwinist, observed that "most animals are multicellular," but remained puzzled; "why, we do not know."[288] Surely, "increasing organization exists for a purpose." Perhaps, it is an "advantage … in utilization of environmental energy."[289] Still others agree that "there is no reason to suspect any urge or desire towards complexity by the evolving organisms."[290]

In truth, evolution is motion; and motion implies departure as well as arrival, the production of simplicity as well as complexity, divergence as well as convergence. A complex structure becomes complex through the convergence of matter or the motion of matter. It becomes less complex through the divergence of matter or the motion of matter. Biological microcosms contract as well as expand. So when converging microcosms produce complexity, it is not for a "purpose" or by "accident," but because that is the only possibility under the conditions. Complexity must be viewed as the "effect" of changes in the univironment, and only then must it be viewed as the "cause" of still other changes to come. From this perspective, complexity is the result of "environmental energy" and never a preparation for it.

What is the Direction of Evolution?

The direction of evolution is in each instance toward univironmental equilibrium. But according to Chardin, "biologists are not yet agreed on whether or not there is a direction (still less a definite axis) of evolution."[291] Similarly, Garrett Hardin believed that "the concept of progress, for all its historical importance in sheltering the idea of evolution, is not easily applicable to facts of biology. There may be a sense in which it is useful to say that progress has occurred but we have not yet discovered it."[292] Supposedly, "'nature is too disorderly' for those who seek … unidirectional evolution everywhere."[293] For neo-Darwinists, the direction remains unclear even though they have a law for it.

> In despair of ever finding an important pattern to evolution, some biologists assert that the only generalization that can be safely made is that which has been christened "Dollo's Law": Evolution is irreversible. The paleontological record supports this generalization, and no one seriously believes that the law will ever be violated. But is the idea so profound that it deserves a name? Evolution is a part of history. No part of history ever repeats itself. The irreversibility of evolution is no more, and no less, mysterious than the irreversibility of history in general.[294]

Hardin insisted that "Darwinian adaptation is not in its essence a progressive change, but merely a dynamic way of preserving the status quo."[295] Like other conservatives, Hardin seems ever hopeful that the status quo is a real possibility although Dollo's Law clearly denies it. The status quo is never really preserved indefinitely, because all changes result in new univironments that, although they may be *similar* to those of a former time, are never *identical*.

If neo-Darwinians are unable to recognize a direction to evolution, it is because they fail to see how all-inclusive evolution really is. By considering some things as subject to evolution and others not, neo-Darwinians are apt to reveal an unscientific bias. Thus, in the name of science certain genes,[296] deaths, and extinctions[297] are pronounced "bad" and others are pronounced "good." Some neo-Darwinians, like their cousins the social Darwinists, are known to harbor the suspicion that certain kinds of evolution are "regressive." Miller and Miller, for example, suggest that "Perhaps the most effective present-day evolution of man is being caused by a lack of genetically selective deaths, so that genetic defects are being perpetuated in the gene pool."[298]

Not surprisingly, this viewpoint usually is professed by those who do not suffer from the so-called "genetic defect" being discussed. Such statements merely reflect an ignorance of the all-inclusive nature of evolution. According to Univironmental Determinism, whatever exists is adapted to its environment as long as it exists. In this view, if a particular genetic combination continues to exist within a population, then the univironment is sufficiently stable for its continued existence. There are numerous examples of genetic conditions that are no longer as debilitating as they once were, simply because environments have changed. PKU (phenylketonuria), for example, no longer leads to mental retardation, because the environment of this "genetic defect" now includes routine screening and special diets for those infants who are affected. Likewise, many physically handicapped people are able to survive and lead useful lives because modern environments include others who support their efforts. All these people are adapted to their environments, and "genetically selective deaths" are uncalled for.

Requiem for Neo-Darwinism

Like all expedients, neo-Darwinism, the mechanism of evolution conceived as the combination of occasional natural selection and the gene as the organism personified, will meet a timely, evolutionary death. In a way, it will be sad to see this theory go. It was, after all, a deterministic improvement upon its predecessors. It guided biology, though errantly, through more than a century of progress. Its displacement will not be easy, for at bottom, the struggle between Univironmental Determinism and neo-Darwinism must become a significant historical phase in the eternal clash between the two great philosophies, determinism and indeterminism.

Today the scientific world cries out for a universal theory of evolution, but it cannot have one without overtly embracing determinism. In so doing it must discard the microcosmic bias of systems philosophy and adopt the univironmental view instead. The evolution of any microcosm is never a "self organizing" process, but the result of the reciprocal interaction of microcosm and macrocosm. The special relationship between evolution and biology must be destroyed. The midwives of the idea of evolution must yield their charge to a broader perspective. Evolution is not merely the property of every living thing; it is the property of every single thing.

Chapter 7

Univironmental Analysis

> The goal of univironmental analysis is to give equal consideration to the main features of the microcosm and the macrocosm for predicting the motions of the microcosm.

We have already learned that the microcosm always moves toward univironmental equilibrium: an equalization of motion between the microcosm and the macrocosm. Similarly, the human mind, consciously or subconsciously, tries to make sense of its world by alternately considering the main features of the insides and outsides of things, a process I called *univironmental analysis*. On the grand scale, classical mechanics was a look at the outsides of things, while systems philosophy was a look at the insides of things. But if the motions of the microcosm are really determined by the motions within the univironment, then it behooves us to emphasize equally both the microcosm and the macrocosm. As the trends in scientific philosophy of the past three centuries demonstrate so well, such *univironmental thinking* is extremely difficult to achieve. One group of indeterminists beckons us to come outside; another beckons us to come inside. As in an earthquake, we had best try to stand in the doorway lest we be struck by the debris of defunct philosophies.

As scientists, we must be aware of the siren calls of those biased in favor of either the microcosm or the macrocosm. We must be aware of the effects of such philosophies on our own thinking and must endeavor consciously to set a balanced course. Univironmental analysis is best developed only through hands-on practice, but in this chapter I attempt to provide the next best thing in the hope that it will further stimulate you to apply it more rigorously in your everyday life.

An improvement in univironmental thinking is possible for all of us. But as assumed under *uncertainty*, complete knowledge of either the microcosm or the macrocosm is impossible. Just as no microcosm ever reaches perfect, absolute, final univironmental equilibrium, no mind can achieve a perfect univironmental analysis. Although we may revere such a goal, "we cannot with certainty attribute observed constraint either to system or environment."[299] We can never be absolutely certain what the "main features" of a univironment are, much less determine their "primary motions" with perfect accuracy and precision. In short, we make mistakes.

Mistakes

The harder we push our knowledge, the further we venture into the unknown, the more often we make mistakes. Mistakes, of course, can be nasty events—it is the business of life to avoid them. In consequence, we all have a tendency to favor the known and to avoid the unknown—for safety, if for no other reason. This conservatism poses a special problem inherent to the process of thinking. Even those who may agree that all microcosms must be analyzed from a univironmental point of view cannot avoid overemphasizing what they know and underemphasizing what they do not.

All knowledge is to a degree special knowledge, and every person is to a degree a specialist. Our emphasis naturally tends to be in the area of our specialty, and we will tend to ignore those features of the universe we know less about. Accordingly, a specialist who has studied the relations between submicrocosms within a particular microcosm will tend to overemphasize microcosmic factors, and a specialist who has studied the relations between supermicrocosms within a particular macrocosm will tend to overemphasize macrocosmic factors when asked about the univironmental relationship of the microcosm as a whole. It can be no other way. By definition, a special bias accompanies every specialist. To a hammer, everything in the world is a nail.

As an example of the above phenomenon, we can examine any of the perennial pseudo-debates in which so-called scientists are asked to evaluate a reciprocal relationship between a microcosm and its macrocosm. One of the most popular is the nature-nurture controversy, which I will discuss in more detail later. For now, let me point out that it is a rare geneticist who emphasizes the nurture side of the argument; it is a rare sociologist who emphasizes the nature side of the argument. In relation to their analysis of the motions of a particular microcosm, we must be wary of the interpretations of specialists whose knowledge lies predominantly on one side of a particular univironmental boundary. Thus, all knowledge, because it is in some sense special knowledge, is prone to two types of error of overemphasis: microcosmic and macrocosmic.

A *microcosmic mistake* is an overemphasis on microcosmic factors in the analysis of a particular univironment. A *macrocosmic mistake* is an overemphasis on macrocosmic factors in the analysis of a particular univironment. While the objective of scientific analysis is to avoid either of these mistakes, such mistakes plague every scientific interpretation. Furthermore, because it is decidedly in the interest of indeterminism to perpetuate them, the literature is replete with glaring examples of such mistakes, many of which will be pointed out throughout the remainder of this book. Two short, culturally popular examples amplify what is meant by these two types of overemphasis.

Microcosmic Mistakes

Many of us drive vehicles. Whether or not a particular vehicle reaches its destination safely depends on only two things: what is inside of it and what is outside of it. The most intelligent passengers at least subconsciously realize this, and even though they may have high regard for the abilities of the driver of the vehicle in which they ride, they may not have similar regard for other drivers on the road. Consequently, they take additional measures to protect themselves in case of an accident. Typically, those who do not wear seat beats often alibi with the comment "I trust you," directed to the driver. Their microcosmic mistake: believing that the driver of their vehicle has the power to prevent all accidents.

Macrocosmic Mistakes

Certain people are afraid to drive at all. Often, these people fear that the macrocosmic risk is greater than it really is. Like the fear of flying and other "irrational" phobias, this one is founded on a few aspects of reality that have been exaggerated out of proportion. There are two major approaches to blunting the effects of such phobias. One is for the counselor to appeal to reason, perhaps emphasizing the safety features of the macrocosm, such as the low frequency of accidents, the universal availability of driver training, the enforcement of speed limits and motor vehicle regulations, etc. Another is for the counselor to build the self-confidence of the person suffering from the phobia, perhaps by encouraging the development of skills for preventing the feared calamity. Success depends on putting both approaches to work in the development of practical means for interacting with the macrocosm.

Examples of Univironmental Analysis

The following section gives examples of univironmental analysis, progressing from the simple (the motions of a balloon) to the complex (the motions of burning wood). These examples should develop proficiency in viewing the world univironmentally and, therefore, scientifically.

The Motions of a Balloon

A child's toy balloon is excellent for illustrating the basic principles of univironmental analysis. As with all microcosms, what happens to a balloon depends on only two things: that which is inside it and that which is outside it. Filled with air, it sinks in air and rises in water. Filled with water, it sinks in both; filled with helium, it rises in both. Placed in a vacuum, it expands and bursts. It is impossible to predict the movements of a balloon without knowledge of both the microcosm and the macrocosm. Indeed, an inflated balloon clearly owes its existence to the delicate balance between microcosm and macrocosm.

Unlike many other microcosms, an inflated balloon has a rather clear boundary, an interface that appears to separate the outside from the inside. The motions of a balloon are so obviously dependent on the univironment that, after a few experiments, even very young children can make rather accurate predictions about its movements.

Children do not need to know the technical details: a helium balloon rises in air because it weighs less than the volume of air it displaces. The macrocosmic impacts from below are not completely counterbalanced by those from above and there is a net acceleration of the balloon away from the earth. Not until the motions on all sides of the balloon are more or less equal does the balloon come to "univironmental equilibrium" (i.e., "rest").

But "rest," of course, is only apparent and ephemeral because the motions of matter within the microcosm and within the macrocosm continue. If the balloon is outdoors, the macrocosm can easily change through warming by the sun and disturbance by the wind. Even the helium in the balloon does not stay there long. The walls of the balloon are also in motion. They are permeable as well as flexible—a fact seldom lost on children who awake in the morning to find yesterday's marvelous toy lying limply on the floor, the helium having escaped during the night.

The Motions of Table Salt

As mentioned previously, the boundaries of a particular microcosm must be ever movable. The infinitely complex motions involving "simple" table salt, sodium chloride, illustrate this point. The microcosm of a beaker of saturated sodium chloride solution is, of course, quite different from that of a microcosm of a crystal of sodium chloride or of the microcosm of a sodium ion or of a chloride ion.

Without realizing that all reactions are, in the strict sense, irreversible and that all movements are toward "univironmental equilibrium," we could make little sense of them. The classical concept of "dynamic equilibrium" considers a beaker of saturated salt to be "stable" and at rest. According to the conventional account, the motions that occur within the beaker are "reversible" and would not necessarily be considered motions toward "univironmental equilibrium." Taken as a whole, and seen as isolated from its macrocosm, the motions within the beaker appear aimless and directed to no particular end. Sodium and chloride ions continually leave the surface of the salt crystals, enter the solution phase, and return to the crystal again. Indeterminists characteristically "explain" these motions by emphasizing their probabilistic or random nature as though they were acausal.

Nevertheless, by constructing the imaginary boundaries of the microcosm properly, the "evidence" for randomness[300] and the implied acausality disappear, and we see movement toward univironmental equilibrium instead. This is realized by considering each individual sodium or chloride ion as a microcosm surrounded by its own peculiar macrocosm.

The macrocosm of a sodium ion in the middle of a sodium chloride crystal is radically different from one in solution or from one on the surface of the crystal. Each sodium microcosm responds to changes in its macrocosm, moving toward univironmental equilibrium. A sodium microcosm on the surface of the crystal will remain there only so long as the univironment does not change significantly. It moves into the solution only when its relationship with the macrocosm changes. The macrocosm in this case consists of water molecules, hydroxyls, and hydronium ions as well as chloride ions and other sodium ions. Generally, a sodium microcosm on the surface of a crystal remains there for only a short time. This is to be expected because the interface between the crystal and the solution is the locus of the most rapid changes and the place *where new evolutionary developments occur first*.[301]

Returning our attention to the microcosm of the beaker, we observe once again the so-called "reversible" motions that occur at equilibrium. At equilibrium, the net effect of all that motion from crystal to solution and back again amounts to what indeterminists see as "no net change." Indeed, if one views the beaker as an isolated system, the movements within take on a truly miraculous character. Such movements have been mistaken as evidence for a soul,[302] or for "psychic energy,"[303] and who knows what else. But if we view the beaker as a microcosm, the mystery disappears, for there is little chance of approaching what scientists normally define as equilibrium in anything but a macrocosm whose motions are relatively constant. Those who mistakenly regard equilibrium as a system property rather than a univironmental property invariably have taken great pains to carefully control the conditions of the macrocosm, the temperature, pressure, etc.

As explained under *inseparability*, temperature measurement is a fundamental method of studying the motion of matter. Because a constant temperature is one of the requirements for the so-called equilibrium of the system, its measurement is a tacit admission of the effect of the macrocosm on the microcosm. True isolation would be the absence of a macrocosm, the absence of temperature, i.e., absolute zero. But as we have seen, absolute zero is found nowhere; matter in motion is found everywhere.

Constant temperature provides a relatively unchanging environment for the "equilibrium" within the beaker, but the necessity of an external temperature implies that the reactions within the beaker are, in a sense, "fueled" by the motions of the macrocosm. For a demonstration of this, we need only lower the temperature of the beaker's surroundings. The reactions within begin to slow as the motions of the atoms within the microcosm of the beaker are transferred to the macrocosm. Slower and slower are the movements within as we decrease the movements without. To achieve the state of "no motion," this process would have to descend an infinite number of infinitesimal steps toward absolute zero—an impossibility. For all but the die-hard systems philosopher, the logical conclusion is that *a microcosm without a macrocosm is impossible*.

The Motions of Rusting Iron

Most everyone is familiar with the changes that occur when we allow iron metal to exist in an environment containing air and water. Iron rusts because rust, FeOOH, is more stable under such conditions than metallic iron, Fe. High heat and special conditions are required for producing iron metal, but these conditions are maintained only for a short time. Once the macrocosm of high heat, etc., is removed, it is all "downhill" for iron. Atmospheric conditions and room temperatures can neither produce iron metal nor can they preserve it indefinitely.

We may try to isolate a piece of newly milled iron from its new macrocosm containing the elements that will destroy it. We can paint it or store it in a macrocosm with low humidity and/or low oxygen, but change occurs all the same. Whatever we do to protect the microcosm of the iron from the macrocosm is only a delaying measure, for complete isolation is impossible. No univironmental boundary is completely impermeable. We simply hope to decrease the rate of change and maintain temporary stability by providing a macrocosm that has characteristics most similar to the macrocosm of the metal's formation (i.e., low oxygen, low hydrogen).

When matter undergoes relatively simple transformations, as iron does, we can write chemical reactions describing the change:

$$\underset{\text{iron}}{2Fe} + \underset{\text{oxygen}}{2O_2} + \underset{\text{water}}{2H_2O} + \underset{\text{motion}}{\text{kcal}} \rightarrow \underset{\text{rust}}{2FeOOH} + \underset{\text{hydroxyl}}{2OH^-} + \underset{\text{motion}}{\text{kcal}} \qquad (7\text{-}1)$$

Chemists frequently draw such reactions with two arrows pointing in opposite directions, indicating that a reaction may be "reversible." But, as we are well aware, the rusting of iron proceeds all too rapidly in the direction described by the arrow in reaction 7-1. Because iron in the macrocosm of ambient temperature and pressure is so far from any sort of equilibrium—"systemic" or otherwise—most chemists would not draw an arrow in the opposite direction.

Whenever a chemical change occurs, motion is exchanged as well. In this case, a tiny amount is absorbed and a large amount is emitted when the iron combines with oxygen and hydrogen to form rust. This motion is transmitted to the macrocosm, the area surrounding the rusting metal. The microcosm of metallic iron, air, and water loses motion irreversibly—its mass decreases slightly though insignificantly. The submicrocosms within move at slightly lesser velocities after the reaction than before. The microcosm of rusted iron is now more in tune with the "fast" environment of oxygen and water and a new univironmental equilibrium has been produced.

To convert the microcosm of rust back to iron, we must put it into a macrocosm in which iron is more stable than rust. Such a macrocosm must include other submicrocosms possessing the rapid motion called heat and an element such as carbon that will form chemical combinations with the oxygen in rust, thereby removing it from its association with iron. In this special macrocosm, the O and H atoms are more stable combined as the gases CO (carbon monoxide) and H_2O (water), than in combination with Fe. Likewise, the Fe atoms, having lost their accompanying O and H, are left to associate only with each other as the molten iron. The rather distant relationship between Fe atoms at high temperature becomes one of greater proximity when sufficient motion is lost to the macrocosm as the molten iron cools. The thermal motions of the iron atoms diminish as they collide with and transmit some of their motion to slower submicrocosms within the macrocosm. The cooler the molten iron gets, the slower the molecular vibrations of the Fe atoms, the greater the bonds between them, and the more ordered or organized is the structure.

At room temperature the molten mass cools to form a solid that still contains vibrating atoms of iron. Once again, in a macrocosm containing air and water at ambient temperatures these iron atoms will have less motion only in combination with some of the oxygen and hydrogen of the macrocosm. Once again, the reaction proceeds toward univironmental equilibrium.

The Motions of Burning Wood

For most of humanity's existence, fire has been a deep mystery. Its obvious reality led it to be considered a "thing," much as light is so considered by many today. But, as Bronowski put it so well, "Fire is not a material, any more than life is material. Fire is a process of transformation and change, by which material elements are rejoined into new combinations."[304]

Note that Bronowski's quick success in demystifying this extremely complicated phenomenon was due to his first answering the fundamental question: is it matter or the motion of matter? Fire is not wood, hydrogen, carbon, or oxygen, but the infinitely varied *motions* of these things. Below I present some of the details involving the transformations and combinations to which Bronowski alluded. The univironmental analysis of burning wood is good practice for understanding the especially sophisticated motions of matter to be encountered in later chapters.

To begin with, wood consists mostly of carbon (C), hydrogen (H), and oxygen (O) in molecular combinations that are relatively stable under most atmospheric conditions. It takes a special environment, a unique macrocosm, for wood to become noticeably unstable—that is, for its submicrocosms to demonstrate the motion that is fire. A lighted match provides an important part of such a unique macrocosm, with the reaction proceeding as follows.

$$\underset{\text{wood}}{C_xH_yO_z} + \underset{\text{oxygen}}{O_2} + \underset{\text{motion}}{\text{kcal}} \rightarrow \underset{\text{carbodioxide}}{xCO_2} + \underset{\text{water}}{y/2H_2O} + \underset{\text{motion}}{\text{kcal}} \qquad (7\text{-}2)$$

A small amount of motion provided by the match (activation energy) is required to initiate the reaction. The match or other heat sources, as well as the oxygen, must be included in the macrocosm. Only when the match and the oxygen converge on the microcosm of the wood does the reaction begin. In addition, we must also consider the microcosm—the "insides" of the wood—as part of the univironment of fire. Woods of differing type have varying activation energies depending on moisture, oil content, size, and so on. The amount of motion that can be transmitted by a match is, of course, limited and thus a match will activate only a limited amount of wood, such as a twig or a small branch. High temperatures (more frequent macrocosmic impacts) are necessary to ignite a large chunk of wood.

In this simplified picture, the carbon atoms receive motion from the lighted match, causing them to vibrate so fast that they eventually are loosened from the wood along with other elements. Methane (CH_4), a gas, is one possible result of this so-far incomplete combustion. The motions of the air molecules, too, are such that they frequently collide with the methane molecules, but the effect of these collisions is not everywhere the same. A microcosm of methane undergoes more frequent and higher velocity impacts on the side of the molecule facing the earth, where concentrations of air molecules and other gases are greatest. Methane gas molecules diverge upward from the wood because, of all possible directions of travel, this generally involves the least resistance from other matter.

As the methane rises through and collides with air, it contacts oxygen molecules. Some of these collisions result in chemical bonds that increase stability (reduce relative motion) for both carbon and oxygen. Consequently, carbon dioxide (CO_2) is formed (reaction 7-2). At the same time, the hydrogen atoms in the microcosm of methane also contact the oxygen. In such a macrocosm, hydrogen atoms exhibit less motion in combination with oxygen than with carbon. Water (H_2O) is the result.

The burning of wood takes place in less than a second, and yet all these reactions and many more occur, each resulting in univironmental equilibrium. The motions of the microcosm increase or decrease at the expense or benefit of the macrocosm. The microcosm of the wood can be impacted by high velocity supermicrocosms, as in the case of the lighting match, thus gaining motion; or it can collide with lower velocity supermicrocosms, thus losing motion. The microcosm of the burning wood may be surrounded by air molecules or perhaps a kettle of water. The kettle, in turn, may be the macrocosm of yet another microcosm, such as a bit of food, for example. Or we can view the kettle itself as a microcosm. If the kettle is set aside to cool, the rapid motions of its molecules will be transmitted to lower velocity supermicrocosms within the macrocosm. This motion is then transferred, microcosm-to-microcosm, perhaps eventually even to increase the motions in the skin of some strange being in a distant galaxy.

How to View the World

The explanations above all have one characteristic in common: they alternately emphasize microcosmic and macrocosmic features of the univironment. Overtly, if crudely, they attempt to avoid the macrocosmic mistakes of classical mechanism and the microcosmic mistakes of systems philosophy. The "cause" for the motion of a microcosm is not to be attributed to either the microcosm or the macrocosm, but to both. A microcosm moves only to the degree that the macrocosm does not resist that motion. Even our transient consideration of first the microcosm and then the macrocosm does not accurately reflect the reality of the univironment. We must be content with mere glimpses of a few of the infinity of submicrocosms and supermicrocosms that lie within and without even the simplest of microcosms. We are obliged to make finite, fallible predictions in a world controlled by an infinite reality. Nevertheless, we can always improve the accuracy and precision of our predictions by including more and more of the infinity of causes that constitute the "main features" of the univironment.

As seen in the examples above, a microcosm can be anything we wish it to be—any portion of the universe. In this view of the world, the isolated, finite system disappears and we no longer attribute the activity of a thing to its internal motions alone as the solipsists do. Neither do we consider anything to be inert and totally controlled by its environment as the fatalists do. In univironmental analysis we stress the reciprocal relationship between the microcosm and the macrocosm.

So far we have covered the Philosophy, the Assumptions, and the Method of what I call the Scientific Worldview. In the last half of the book I provide a cursory analysis of a few important aspects of the world generally touched on by scientific philosophy. The implications of this foray are more than I originally bargained for. It would appear that, from the univironmental point of view, many of our current theories have led us astray. The ones I propose as replacements, I hope you will understand, are highly speculative and require extensive theoretical and experimental development. Nonetheless, they are univironmental speculations and, as such, I believe them to be preferable to older theories based on the indeterministic assumptions of classical mechanism and systems philosophy. Some of my ideas may at first seem quite strange, but none, I trust, are as fantastic as the prevailing view that the universe exploded from a point no larger than the period at the end of this sentence.

Part Four

The Analysis

Chapter 8

The Infinite Universe

Nature is infinite.[305]

When it is finally laid to rest, the theory of the "Big Bang" origin of the universe[306] will be recognized as the most acute embarrassment of twentieth-century science. The Big Bang Theory is by most accounts highly speculative, but most cosmologists and astronomers nonetheless take it seriously. And well they should, for it is the logical culmination of a series of important supporting theories and interpretations developed at the behest of the current scientific worldview: systems philosophy.

Descriptions of the Big Bang vary. A few proponents imagine a finite universe surrounded by "empty space" into which this universe expands and from which it might return by "gravitational attraction." Most claim that the expansion is self-contained within a four-dimensional spacetime fabric—whatever *that* is. Most propose, either explicitly or implicitly, an "origin" for the universe when, according to *infinity*, it had no origin. Those especially in tune with scripture are even inclined to speak of an initial and a final chaos—a beginning and an ending for all things as if in the fires of an acausal hell. The Big Bang Theory is so well-seated in the current culture that its inevitable rejection and replacement by an infinite universe theory will mark the renaissance of determinism and a veritable revolution in science.

Like the theory of the flat earth, the Big Bang is a showcase reflection of the philosophical assumptions of the society from which it sprang. Both theories were logically consistent deductions from narrow premises that seemed reasonable at the time. Viewed from a wider perspective, however, both the flat earth and the Big Bang must be considered paramount microcosmic mistakes.

As seen from the univironmental point of view, the theory of the Big Bang is patently absurd. How could so many otherwise intelligent and talented scientists have gone so wrong? Cosmological theories come and go, but the Big Bang stands out as a bold, oddly curious product of an era otherwise known for its commitment to somber investigation. Let's face it, a theory as important as the Big Bang could not exist unless it was consupponible with a large number of supporting theories and assumptions common to science in general. As I intend to show in this chapter, the Big Bang is so well tied to these other interpretations that those who take exception to it must also take exception to the way we do science in the twentieth century. As demonstrated on numerous occasions during the last three decades, piecemeal attacks lacking the proper philosophical base will leave the Big Bang unscathed.[307] We should not be shocked that all data tend to support a microcosmic theory when they are viewed from a microcosmic perspective. The Big Bang Theory is both the epitome and the grand finale of systems philosophy.

Microcosmic Interpretations Supporting the Big Bang Theory

There are countless indeterministic interpretations used to support the Big Bang Theory. Only four of them, however, need consideration here to undermine the theory. They include the notions of: heat death and chaos, attraction, curved space, and expansionism. When our philosophical perspective on these topics finally changes, the Big Bang Theory will collapse.

Heat Death and Chaos

The universal generalization of the Second Law of Thermodynamics (SLT) has been with us since 1856 when Hermann von Helmholtz concocted it. Otherwise known as the "heat death of the universe," this interpretation assumes that the universe, like other finite, ideally isolated systems, must become more rundown and disordered over time. The appellation "heat death" refers to the fact that heat, like all motion, is transmitted from regions of plenty to regions of scarcity. Thus, for example, the sun loses motion to its surroundings and eventually will burn out. Like all individual portions of the universe, the sun's loss of motion to the macrocosm eventually will cause it to go out of existence. By generalizing from such particulars, indeterminists typically argue that "Since the same fate is reserved to all other stars, the universe will eventually die the death of temperature equalization foretold by the second principle of thermodynamics."[308]

Those who assume the SLT can be generalized in this way invariably forget that the SLT was discovered by imagining *perfectly* isolated systems that do not exist, but was supported by data from *nearly* isolated systems that do exist. A finite, perfectly isolated universe could not exist. Thus, an indispensable law applicable to any particular portion of the universe has been misapplied to *all* of it. Only in the idealist's finite universe, surrounded by "empty space" and governed by *separability*, does motion without matter escape into the void, never to return. Thus separated from its motion, the matter in this imagined universe reaches a perfect, final equilibrium in which its various parts attain a state of eternal rest.

While the heat death interpretation fantasizes the "final" dissipation of motion, the allied concept of "chaos" fantasizes the final disposition of matter. All systems appear to have a degree of structure or order. According to the SLT, when a system is ideally isolated from its surroundings its structure tends to break down and it becomes increasingly disordered or "chaotic" as its entropy increases. If one assumes that the universe is a "system," finite and isolated from its surroundings, then of course it must become more and more chaotic with time. We know that "left to themselves, things tend to go to hell." A finite universe would be no exception.

Chaos, it must be remembered, was also the starting point in biblical mythology. The creation of the universe, like the building or creation of anything, would have required considerable outside influence. Having mentally stripped the universe of the material surroundings necessary for its existence, the scribes of Genesis were forced to invent immaterial surroundings as a replacement. Thus it was no mere coincidence that, with the rise of systems philosophy in the twentieth century, a man steeped in religious tradition, the Abbe Georges Lemaitre,[309] would attend the birth of the Big Bang Theory.

For more than three centuries science had subverted religion; now it was religion's turn to subvert science. Systems philosophy accepted Lemaitre's imagery with open arms. The galactic redshift was cherished as proof that the whole universe had exploded out of a cosmic egg, thereby producing order out of chaos. Scientists, such as L. L. Whyte, whose philosophy "transcended both science and religion," suspected nothing amiss; "cosmologists find it best to assume" that "in the beginning was Chaos."[310] Helmholtz's speculation has become so ingrained in thermodynamics that even famous Nobelists have been known to start their theoretical analyses with "an initial chaotic situation"[311] and end them with the "completely chaotic behavior resulting in death."[312]

Of course there is a wisp of truth in the myth of an initial and a final chaos. Does it not parallel the ebb and flow of our own lives? We see the birth and death of microcosms within the universe, coming, as they say, from dust and going to dust. Why not the same for the universe as a whole? For believers in *finity* every law, not just the SLT, must be consistent with an ending for the universe, a grand divergence into nothingness. The flip side of that interpretation requires a similarly grand beginning. It might as well have been with a bang.

The Cure: *Complementarity*

As mentioned under *complementarity*, the divergence of microcosms from one place is at the same time a convergence upon another place. Together, divergence and convergence form a dialectical unity that is the essence of motion. The individual submicrocosms within a particular microcosm diverge from each other, their movements succeeding best in those directions in which the macrocosm temporarily offers the least restraint. Eventually, each submicrocosm leaves the microcosm and continues through the macrocosm, where, in an infinite universe, it is always part of yet another microcosm.

An observer of the first microcosm may see increasing "disorder," while an observer of the second may see increasing "order." The first may shout "there it goes!" and the second may shout "here it comes!" The first may foolishly generalize "the universe is expanding!" and the second may just as foolishly generalize "the universe is contracting!" Both would be wrong. In an infinite universe, a divergence from one point is a convergence on another. Every departure implies an arrival—the inescapable nature of motion itself. It becomes obvious then, at least to those not overly satisfied with the old view, that *complementarity* destroys any objective possibility of chaos, disorder, heat death, or expansion for an infinite universe. Acceptance of this dialectical symmetry demands an outright rejection of any theory of the universe based on universal expansion or of origin.

Attraction

To hear systems philosophers tell it, we still live in an attractive universe. When two microcosms converge as a result of inertial motion, the anthropocentric tradition tends to view them as being "attracted" to each other. But as Newton himself warned, the idea of action-at-a-distance implied by gravitational attraction is "so great an absurdity that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it."[313]

As to the cause of gravitation, Newton was notoriously noncommittal. In a letter to the Reverend Richard Bentley he wrote, "You sometimes speak of gravity as essential and inherent to matter. Pray do not ascribe that notion to me, for the cause of gravity is what I do not pretend to know."[314]

Newton's equation describing gravitation worked despite the name given to the phenomenon or how it was viewed. Nevertheless, he could not avoid the greater philosophical issues, and at one time was of the opinion that if the equations actually applied to a finite universe "all matter would fall down from the outsides and convene in the middle."[315] That this did not happen he attributed either to the existence of an infinite number of bodies in the universe or to the existence of a supernatural power. Today's cosmogonists attribute it to the Big Bang.

Einstein and his many followers thought he had solved the problem with his General Theory of Relativity. In the Principle of Equivalence, he had taken a giant step toward destroying the concept of attraction, correctly observing that gravitation and inertia were identical phenomena. At this point, unfortunately, he made a critical error that was to bedevil him the rest of his life.

Under the influence of the mathematician Georg Riemann, Einstein laid out the possibilities for positively curved, negatively curved, and flat space. Only one of these was in tune with *finity* and the system-oriented perspective that was gaining popularity. Einstein ended up living in a universe that was finite and unbounded—nothing anyone could even imagine. In lieu of overt attraction, he left us with a Riemannian magical mystery tour that would eventually support the Big Bang Theory.[316] In no other way could modern Copernicans reconcile the expanding universe hypothesis with their intuition that the earth could not be at the center of the expansion.

The Cure: The Univironmental Theory of Gravitation

From the univironmental perspective it is clear that gravitation must be the result of a push, not a pull, much as proposed in a 1784 paper by G. L. Le Sage.[317] In reducing univironmental determinism to neomechanics, we saw that motion can be transferred only through inertial contact between microcosms that give up or take up motion. Going one step back in the logic, we assumed with *inseparability* that there can be no motion without matter, just as there can be no matter without motion. A change in the inertial motion of one microcosm with respect to another thus requires the interaction of material bodies. What is at first seen as "action-at-a-distance" is, according to our assumption of *interconnection*, a result of the inertial action of intervening microcosms. To date, neither "pullers" nor "pushers" have been accepted as the physical agents responsible for gravitational effects. This instrumental difficulty reinforces indeterminists' longstanding contention that absolutely no intervening material bodies are necessary for matter to "attract" matter.

To one less mystically inclined, it appears more likely that gravitation is the result of unseen material bodies than of an immaterial "attractive force." Because neomechanics theoretically can have no pullers, we will dismiss that possibility out of hand and concentrate on pushers. Subsequent to Le Sage, speculations involving the push hypothesis have been advanced regularly in various forms.[318] The push could be performed in one of two ways: 1) by high-speed particles (gravitons?), or 2) by high-speed longitudinal waves in a medium consisting of particles (gravitons?). Current government-supported work involves the search for gravitational waves, the general idea being to detect the results of explosions or collapses of celestial bodies. The success of the project would put the kibosh on the attraction hypothesis. Systems philosophy would shudder, but probably would regain composure by interpreting the data as yet another "proof" of Einstein's "space curvature" as the "mechanism" of gravitation. Of course, it really would prove nothing more than that space is not empty and that it contains a material medium capable of transmitting motion over great distances. Most gravitation probably follows this second path, but I will use the particle theory in the following example because it is easiest to understand.

The falling apple is pushed or "attracted" to the earth in much the same way that dirt is pushed into or "sucked up" by the vacuum cleaner. Because the apple/earth and dirt/vacuum cleaner are clearly visible and the gravitons or air molecules are not, our first impulse is to view these processes microcosmically. We think of the earth as though it were emanating an attractive force in the same way the vacuum cleaner seems to emanate an attractive force. In both cases, of course, scientific explanations of the phenomena require a univironmental analysis. Gravitons are just as important to gravitation as air molecules are to vacuum cleaning. The math is the same whether one regards the basic mechanism in each instance to be a push, a pull, or an immaterial attraction.

The fundamentals of the Univironmental Theory of Gravitation are rather simple. In an infinite universe, all microcosms are subject to convergence from other microcosms varying in size from the infinitely small to the infinitely large. Thus, a microcosm such as the earth moves through the infinite universe, receiving impacts on all sides. Like the inflated spherical balloon, its very form bespeaks of its existence within a macrocosm that is nearly isotropic with regard to this special kind of convergence. Overall, it is the gravitational pressure acting on a relatively isolated astronomical microcosm that prevents the submicrocosms of which it is composed from diverging quickly into the infinite universe.

Next let us consider what happens when two large astronomical bodies come in contact. Ironically, one of the major supporters of the Big Bang Theory, Gamow, nicely described the fundamentals of this aspect of the theory when he reiterated Spitzer and Whipple's theory on light pressure:

> The pressure of light is very weak as far as bodies of normal size are concerned … to demonstrate the existence of that force extra sensitive equipment is required … Since dust particles in interstellar space are illuminated about equally from all sides the effect usually cancels out. But there also will be an effect of "mutual shadow-casting. … [E]ach particle will receive fewer impacts by light quanta coming from the direction of the other one than it will from light quanta from all other directions. As a result of this mutual shadow-casting two particles will be pushed toward each other as if there were an attractive force between them. … [P]seudo-attractive force will vary in inverse proportion to the square of the distance … being similar in this sense to the force of Newtonian gravity.[319]

The relations between galaxies, stars, planets, atoms, and subatomic microcosms can be described in general by a similar mutual shadow-casting effect (Fig. 8-1). Because most microcosms consist of atoms, and because the mass of the atom is contained in only a tiny fraction of its volume, most of the *gravitons*, the hypothetical particles thought to be responsible for most gravitational effects, pass through without impact. At the atomic level, the gravitational effect is produced almost exclusively by those gravitons interacting with the nucleus. This causes the graviton flux to be slightly deficient in the region between two microcosms. In effect, each casts a *gravitational shadow* upon the other. The sides of two microcosms facing each other receive slightly less impact than if no shadow casting occurred. Two microcosms traveling along parallel lines through space are thus pushed toward each other by still other microcosms. If the deflection is great enough, the microcosm of least mass orbits the one with the most mass. If it is still greater, they are forced to form a single microcosm.

Please note that there is no "curved space" or "gravitational field" surrounding either of the microcosms in Fig. 8-1. Like all shadows, the gravitational shadow is not the presence of something, but the absence of something. It cannot exist in the absence of a second microcosm.

In an infinite universe, all microcosms have supermicrocosms that can perform this pushing chore. The sieve-like property of all microcosms allows passage of some of these supermicrocosms so that a third microcosm placed between two microcosms is still subject to gravitational effects. No part of the universe is free from this gravitational interaction. There is no place that screens out all supermicrocosms converging from the infinite universe.

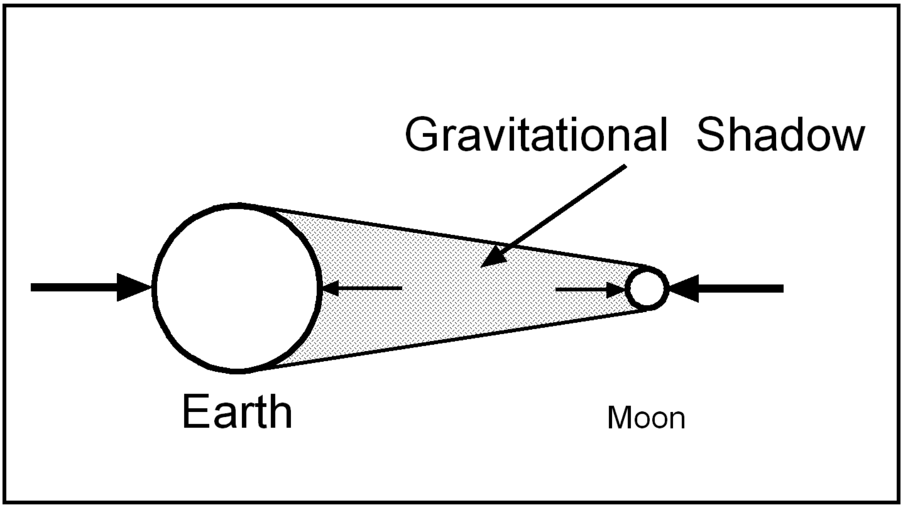


Fig. 8-1. Gravitational shadow casting by the earth, the moon, and the intergalactic sea according to the Univironmental Theory of Gravitation. Some high-velocity supermicrocosms (gravitons, photons, neutrinos, meteorites, etc.) absorbed or deflected by the earth are thereby prevented from contributing motion to the moon, and vice versa. The net result is a tendency for the earth and moon to be pushed (not pulled) toward each other.

The gravitation of microcosms, the pushing together of portions of the universe by still other portions of the universe, thus constitutes a phenomenon of universal generality. It was this phenomenon that Einstein attempted to describe in his "Unified Field Theory" which was to be an explanation of the "four forces" that "hold" things together. He spent more than twenty years in the effort. His followers continue the work, but they will not be successful until they look for a push instead of a pull.

The question arises as to why this universal gravitational pressure occurs in the first place. The answer is similar to the reason light is emitted from stars. Matter and the motion of matter always follow the path of least resistance as proclaimed in Newton's First Law of Motion and reiterated in the Second Law of Thermodynamics. In this regard, the effort to detect gravitational waves[320] is of particular interest. Investigators look to the sky for "bursts" of gravitational energy being "emitted" or "radiated" from galactic explosions, although, paradoxically, they still speak of the "pull of gravity" on earth. If and when gravitational radiation is finally detected, it will confirm that gravitation is a push rather than a pull. In an infinite universe the motion of a microcosm in one place is always transmitted to microcosms in another place. The emission of gravitational radiation is no doubt as common as motion itself.

The observation that microcosms expand and contract has led some to apply that notion to the Big Bang Theory in an effort to construct a finite universe model of infinite duration. The Second Law of Thermodynamics is used to explain the present expansion, and our old friend "attraction" is used to hypothesize an eventual contraction. Much astronomic research effort is currently being spent in the search for the additional matter that would allow such a finite universe to collapse upon itself to trigger the next Big Bang.

No doubt more and more matter will be detected in the intergalactic regions—the amount asymptotically approaching that required for a universe that neither expands nor contracts. From the univironmental perspective a collapsing universe is not a logical possibility. This is because each microcosm requires a macrocosm from which the supermicrocosms must come to push its various parts together. As soon as the impacts from the macrocosm "thin out," the submicrocosms within the microcosm diverge from each other under their own inertial motion as per the Second Law of Thermodynamics. The microcosm expands whenever the impacts from the macrocosm decrease; it contracts whenever the impacts increase. Will the universe collapse upon itself? From the univironmental perspective the answer is an unequivocal *no*.

Curved Space

The fantastic notion of universal expansion must have put a tremendous strain on systems philosophers who were not entirely pre-Copernican in their thinking. Being a small planet encircling a marginal star in the Milky Way, the earth could not be by pure happenstance the center of an expansion involving billions of galaxies. The microcosmic bias that was inclined to accept the expansion hypothesis could not be maintained without a resolution of that problem. How could a finite universe expand without expanding from a single point?

Einstein's General Theory of Relativity provided the way out. A central point is characteristic of a three-dimensional model, but not of the four-dimensional one calculated by Einstein. A four-dimensional universe would be finite and unbounded. It could expand, as it were, into itself. It required no macrocosm, surely delighting the idealists of systems philosophy who looked for and had now found perfect isolation, if only in their heads. Einstein's curved universe kept it all together. Curved space made the universe a system.

Despite Einstein's astute observation that gravitation and inertial motion were one and the same, the systems-oriented concept of attraction did not and could not disappear from the theory of gravity. General Relativity explained gravitation by envisioning a sort of curved space surrounding each body in the universe. There still needed to be some "force" that could cause a body, once in orbit, to move from that perfect curve. Other bodies presumably had their curved space, too, and their being party to a relationship made those curves less than perfect, presumably by issuing a microcosmic gravitational field or "attractive force."

The curved space idea could be generalized. Like the Second Law of Thermodynamics, it was generalized to absurdity. If one made certain assumptions, subsequent deductions would be consistent with the idea that the universe itself was curved. No one could visualize such a universe because the human brain, like everything else, works only in three dimensions. Only by considering time as matter rather than motion could one claim that four dimensions represented reality. While admitting that time was inseparable from matter, modern physicists isolated a whole new dimension for it. A good student of modern physics will not know what time is.

Most people, like most physicists if they were honest about it, could never really understand how curved space worked in the four-dimensional sense. Somehow, people kept going back to the Euclidian reality. It is immensely difficult for Big Bang theorists to keep the public on the Riemannian track without appearing a bit elitist. As one of their promoters admitted, "The most common misconception about the nature of the 'big bang' is the image of a dense lump of matter sitting in the middle of an infinite void and then exploding. … [I]t wasn't just *matter* that was created in the big bang, but spacetime as well. There was nothing 'outside' for the big bang to explode into."[321] It seems that demonstrations with rubber sheets and expanding balloons are not enough to convince unbelievers who find the assumptions of General Relativity unsatisfying and the visualization impossible.

The Cure: Euclidean Geometry

The tendency to believe in the material existence of four dimensions might be called Riemannian Fever—for the man whose hobby was developing geometries in other than the observable three. Einstein, by incorporating time as a dimension, chose the four-dimensional version, deriving the mathematics consistent with *finity*, attraction, and curved space. Riemannian Fever has no known cure other than a good dose of *infinity*.

Infinity is no more difficult to understand than curved space. Besides, one can at least *begin* a physical model of it, which cannot be said for the Riemannian universe. The Scientific Worldview and ordinary common sense coincide on the senselessness of curved space. Both agree with the haunting doubts expressed belatedly by promoter John Gribbin that the Big Bang may be an "illusion" and that, perhaps, "somewhere we have taken a complete wrong turning."[322] Could it be that the four-dimensional emperor has no clothes?

Expansionism

The galactic redshift has been called the most critical observation used in support of the Big Bang Theory.[323] In general, the farthest galaxies appear smaller, dimmer, and redder than the closest ones. Writing for Time Incorporated, David Bergamini's enthusiasm for the indeterministic interpretation of this phenomenon is unlikely to be surpassed: "No insight of science is more meaningful than Edwin Hubble's discovery that the cosmos is expanding—vanishing outward into space like a puff of smoke."[324] Indeed, if the galactic redshift were not primarily a result of the Doppler Effect, the Big Bang Theory itself might vanish in a puff of smoke.

In their excitement in being able to verify the Old Testament, indeterminists avidly brush aside explanations of the redshift that do not lead to such a conclusion. There are, however, numerous interpretations of the redshift and what it means to cosmology.

Redshift-Doppler Equivalence with Macrocosmic *Finity* (The Conventional Interpretation)

Although numerous objections have been voiced for over thirty years,[325] the conventional interpretation is that the galactic redshift is mostly a result of the Doppler Effect. It is well known that the Doppler Effect causes the wavelength of propagated motion to decrease for converging objects and to increase for diverging objects. A common example of the Doppler Effect is the change in pitch from high to low when a noisy vehicle approaches and passes the listener. Thus, in an infinite, relatively homogeneous universe with perfect light transmission, about half of the galaxies would be coming toward us, exhibiting blue light, and half would be going away from us, exhibiting red light (Table 8-1). This is not what is observed. The light from almost all galaxies is redshifted, and thus if the Doppler Effect is the only cause of the redshift, most galaxies are moving away from us and the visible universe truly is expanding. By extrapolating the rate of expansion backward in time, one can calculate the "age" of the universe, the time when the Big Bang occurred. Macrocosmic finity is preserved and anthropocentrism is veiled somewhat with Einstein's indeterministic assumptions that time is a fourth dimension and that space is curved.

Table 8-1. Colors of distant galaxies and brightness of the night sky for various models of the universe.

Transmission[326]	Infinite	Finite
	NON-EXPANDING MODELS	
Perfect	red and blue/light	red and blue/dark
Imperfect	red/dark	red/dark
	EXPANDING MODELS	
Perfect	red/dark[327]	red/dark
Imperfect	red/dark	red/dark

Redshift-Doppler Equivalence with Macrocosmic Infinity

A second interpretation likewise assumes that redshift-Doppler equivalence indicates an expansion of the visible universe. In this view, however, the visible universe is considered only a portion of the infinite universe. One could use neomechanics to argue that the visible universe, like all microcosms, expands and contracts in response to interactions with the macrocosm. It is admitted that the universe as a whole cannot expand because, being infinite, there is nowhere for it to expand into. A three-dimensional infinite universe, by definition, is already full. Variations on this idea sometimes propose a never-ending series of "big bangs" in a desperate attempt to avoid the contradiction between redshift-Doppler equivalence and macrocosmic infinity. The demise of this interpretation is a result of its anthropocentrism—the apparent fortuitousness of the earth's location at the center of the expansion. There are at least a hundred billion galaxies, each having a hundred billion stars, with many of them no doubt having planets similar to ours. Although some religious thinkers might like the exclusivity, they are unlikely to appreciate the macrocosmic infinity and its implications. This interpretation has few adherents.

Tired Light Theory

Einstein and his followers conceived of light as a wave-packet traveling through empty space. There is no known process in which a wave-packet of light would lose energy simply by traveling through nothing. They continued to believe that transmission without a medium nevertheless could record Doppler effects. Distant galaxies in an expanding universe would be red and the night sky would be dark (Table 8-1).

However, as we saw in the chapter on neomechanics, no thing and no motion we know of could traverse the universe without changing in the process. As established as it is, Einstein's view of electromagnetic radiation therefore must be regarded as unprecedented, unique, and most certainly incorrect. Only a rank idealist could believe that space was completely empty and that perfect transmission could occur. Whether light is considered matter, motion, or some imagined "physical combination," it would be impossible for it to travel billions of light years without losses. Although results so far show no significant effect within our own galaxy, some version of the Tired Light Theory ultimately will prevail. Whether the losses are enough to explain that portion of the galactic redshift not due to the Doppler Effect is unknown. The effect is not enough to overcome the blueshift of the nearest spiral galaxy, M31 in Andromeda, which is 2–3 million light years away and hurtling toward us at over 300 km/sec.

Galactic Evolution

There have been suggestions that changes in spectral lines are mainly a result of galactic evolution. Halton Arp is famous for pointing out what he interprets as physical associations between low-redshift objects (white galaxies) and high-redshift objects (red galaxies and quasars).[328] He considers the red objects to be younger than the white objects. He believes that the white objects always orbit the red objects and that the white objects have formed via ejection. To explain this relationship he speculates that galactic evolution involves an unprecedented "blueshift" in which photons are emitted with less energy from young atoms than from old atoms. A look back in time thus would show galaxies at their early stage of development, when they were redshifted. The mainstream has suggested that the high redshifts could be produced by quasar ejection occurring at near relativistic velocities.[329] For decades, the astronomical consensus has been that Arp's "physical associations" probably are coincidences involving nearby white objects in the foreground and distant red objects in the background. For example, the famous fuzzy connections between white galaxy NGC 4319 and red quasar Markarian 205 on Arp's early photos are absent in the improved photography provided by the Hubble Space Telescope.

To make his case, Arp considered both the Doppler Effect and the tired-light effect to be insignificant. If this were true, an isotropic, relatively homogeneous universe would have both white and red galaxies at great distances. This certainly is not what is observed despite his special pleading with regard to measures of distance. All of the really distant galaxies and quasars are red. Arp's heart is in the right place. He knows that the idea of universal expansion is silly, but he is caught in a fatal contradiction. His interpretation allows him to reject Einstein's idealistic theory of space curvature, but forces him to accept Einstein's equally idealistic theory of perfect light transmission.

The Cure: The Univironmental Theory of Light

As preposterous as it is, the idea of universal expansion cannot be rejected without a major change in the theory of light. To move toward this end, we need to discuss some background concerning how we got to this strange theoretical and practical dead end.

As with any phenomenon, we can conceive of light in one of two fundamental ways: as matter or as the motion of matter. Our manner of interpreting the redshift will be set largely by the point of view we select here.

In the first, the *particle* theory, light is conceived as a particle that travels through empty space from star to eyeball at a constant velocity relative to its source. Theoretically, a particle of light would *exist*; that is, it would be a portion of the universe and could be stored in a container. Its half-life would have to be at least a billion years. The particle theory was prominent until the middle of the seventeenth century.

In the second, the *wave* theory, light is conceived as a disturbance of a universal medium, generally referred to as the ether. Theoretically, a wave of light would not *exist*, it would *occur*. It would not *be* a portion of the universe; it would be what a portion of the universe *does*. It could not be stored in a container. The concept of half-life would not apply to it. The wave theory was prominent until the twentieth century.

Almost all the phenomena associated with light and other electromagnetic radiation are described nicely by the wave theory. Nevertheless, the current view of light, *wave-particle duality*, contains elements of both theories—a compromise with a firm historical basis. Einstein's Nobel Prize-winning work on the photoelectric effect in 1905 had convinced him of the discrete nature of the interaction between light and matter, a suspicion confirmed experimentally by A. H. Compton in 1921. Photons, the carriers of light motion, collided with electrons as though they were microcosms, discrete material bodies whose individual motions were describable by classical mechanics, as amended by quantum mechanics. The work seemed to support the particle theory of light. And yet, as mentioned, light had well known wave properties. Wave effects are population effects. A single water molecule, for instance, cannot produce a wave on the surface of a lake. Millions of water molecules must move in unison, generally in directions that are perpendicular to the direction of the wave motion. Likewise, the "wave" sometimes produced by the crowd at a stadium could not occur with only one participant. Einstein single-handedly prepared the reconciliation between the observed discrete behaviors of single photons with the observed population effects responsible for light propagation.

If one assumes that photons travel like bullets at a constant velocity, c = 300,000 km/s, then all photons, assuming they all have identical masses, would have the same energy. This is clearly not the case because electromagnetic radiation of short wavelength (high frequency) has greater energy than radiation of long wavelength (low frequency). For this and many other previously established reasons, a return to the simple particle or ballistic theory of light was not tenable. Neither could light continue to be construed as the motion of a continuous, homogeneous, non-particulate, inelastic medium.

At the turn of the century Max Planck already had derived an empirical equation that related the energy of radiation to its frequency:

$$E = hf \qquad (8\text{-}1)$$

Where:

h = Planck's constant, 6.62×10^{-34} j.s
f = Frequency, cycles/s

The physical reasons for the equation's excellent agreement with experiment remained obscure, however. As explained above, wave effects had always been considered population effects. Planck, however, speculated that radiation was emitted in bundles or packets, *quanta*, which were propagated as waves. Einstein further consolidated the wave and particulate concepts into a single package that found remarkable acceptance from physicists who were by then becoming an active part of the trend toward energetics. Energetics, as explained under *inseparability*, characteristically attempts to conceive of motion and matter at the same time, only to produce a confusing muddle. The photon, as conceived in wave-particle dualism, became the icon of both the energetics and the systems movement.

The upshot of wave-particle duality was the conception of light as both matter and motion, as a sort of materialized packet of motion capable of traveling through empty space. In actuality it was a return to particle theory via systems philosophy. While traveling through the imagined empty space, the wave-packet "system" does not interact with its surroundings, as do all other things. During propagation, Einstein's light is a microcosm without a macrocosm. This is why he was opposed to the idea of ether, the universal medium heretofore considered necessary for light propagation as motion.[330] Not only was ether unneeded, it would get in the way.

As modern physics texts proclaim, the Michelson-Morley[331] experiment of 1887 "proved" that the ether did not exist. But as shown in recent reviews,[332] this was anything but the case. The experiment actually showed a slight *positive* result even though it was performed in a heavily shielded building, at low altitude, and with primitive apparatus having low sensitivity. Between 1902 and 1926, Morley, Michelson, and Dayton Miller at what is now Case Western Reserve University in Cleveland performed numerous experiments with much improved apparatus. Many were done at high altitude under reduced shielding, which increased the effect dramatically. Voluminous evidence was compiled in favor of ether drift.[333] Einstein was keenly aware of this, knowing full well that it would mean the death knell for his theory.

There was no love lost between Einstein and Miller, a highly distinguished physicist who persisted in this effort well after Eddington's irrelevant eclipse observations led to Einstein's glorification. In subsequent debates, Einstein and his defenders generally maintained that the positive results were due to other causes, such as temperature effects. To the uninitiated, this criticism apparently was acceptable because the measurements had large variability and clearly were diurnal; that is, they were high during one part of the day and low during another part. About fourteen years after Miller's death, a special departmental review of dubious quality concluded that the ether had not been detected.[334] As part of this sordid affair, Miller's laboratory notes were discarded and the reviewers received accolades and career enhancements. Einstein no doubt felt vindicated. Nonetheless, the controversy was said to have prevented Einstein from receiving the Nobel for his theory of relativity.

Recent, unheralded experiments in the Ukraine by Y. M. Galaev[335] once again confirmed Miller's detection of the ether. Diurnal variations in the data clearly are *not* temperature effects—they are primarily a function of the earth's rotation, as expected, and as claimed by Miller. Galaev even calculates the ether's viscosity and shows that ether drift measurements are a function of altitude—one of the many reasons Michelson and Morley got only a slightly positive result in Cleveland. Although the measurement is only 200 m/s at sea level, it is 10,000 m/s at 1830 m (Fig. 8-2). Some of the early drift measurements failed because they were conducted under shielded conditions—some were even hypobaric chambers. These completely missed the point. As V. A. Atsukovsky[336] pointed out, it's as silly as trying to measure wind velocity by placing your anemometer inside the building instead of outside the building.

Through univironmental analysis we conclude:

1. The ether is part of the universal medium consisting of dynamic subatomic particles having all the properties and variations in properties normally associated with a medium (density, viscosity, elasticity, etc.).
2. Like all particles, the ones in ether have mass, and appear to be affected by the same particles that produce the Earth's gravity—just like the air molecules in the atmosphere.
3. The gravitational effects produce an *etherosphere* around massive celestial bodies.
4. Like the atmosphere, the density of the etherosphere increases with nearness to the surface of the earth.
5. Like all wave motion, the velocity of light in ether is not constant, but varies as a function of ether density, temperature, viscosity, and elasticity.
6. Unlike the atmosphere, ether is part of the universal medium. Measures of the relative motion between the microcosm of the earth and its macrocosm containing relatively stationary ether should be thirty km/s, the known orbital velocity of the earth. Measurements imply that the etherosphere is over thirteen km thick (42,650 ft) (perhaps not coincidently the same thickness as Earth's troposphere) (Fig. 8-2). Experiments would have to be conducted above this altitude to come close to measuring the full complement of the ether drift produced by Earth's orbital velocity.
7. As the etherosphere thins at still higher altitudes we also should begin to see the effect of the solar system's motion with respect to the rest of the universe (about 370 km/s).
8. The etherosphere responds to increasing altitude much more slowly than does the atmosphere, as might be expected for charged particles. Instead of being a direct function of altitude like atmospheric pressure reduction, it varies with the square root of altitude (Fig. 8-2).

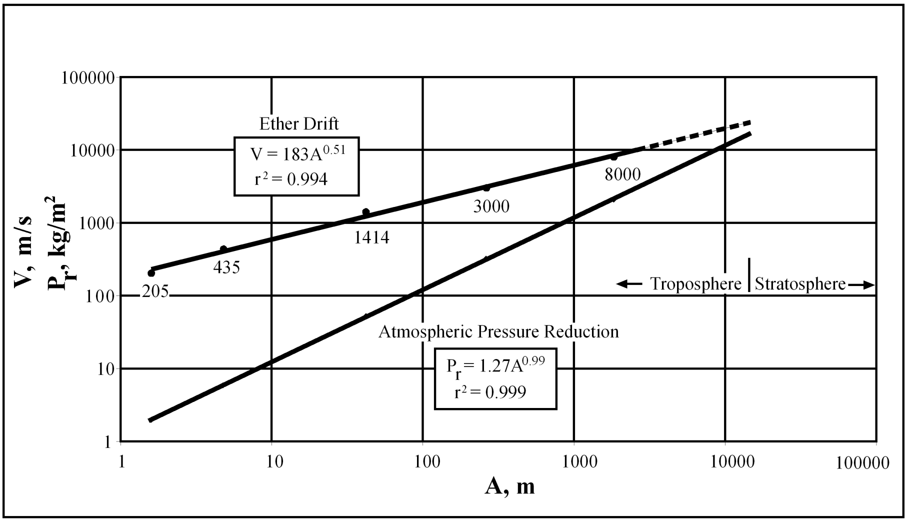


Fig. 8-2. Maximum ether drift measurements versus altitude from the experimental data of Galaev in 2002 and Miller in 1933. Ether drift measurements (V) vary as the square root of altitude (A), whereas atmospheric pressure reduction (P_r) is a nearly direct function of altitude. Projection of the data shows that the full complement of ether drift due to the Earth's orbital velocity (30 km/s) could not be measured within the troposphere.

Einstein's rejection of the ether led to a resounding triumph for indeterminism and systems philosophy. Once light was considered a quasi-system, its interactions with its surroundings could be ignored whenever opportune. This is where the interpretation of the galactic redshift came in. The conventional interpretation sees the redshift as a result of the relative motion of the observer and the observed, rather than as an effect produced through interactions with a medium in the intervening space. As Isaac Asimov summed it up, "There is no known reason why light should lose energy simply because it was traveling through a vacuum for a long time. Furthermore, if it were indeed losing energy in this fashion, no one could offer a reasonable explanation as to what became of that energy."[337]

As mentioned, anyone idealistic enough to believe in completely empty space also must be idealistic enough to believe that light traverses the distance from galaxies billions of light years away *without* losses. From the univironmental point of view, this is impossible. Neither matter nor the motion of matter could be transmitted from one place to another without losses. The dependence of the Big Bang theorists on wave-particle dualism is particularly evident whenever they resort to citing Olbers in support of an expanding, finite universe.

In 1823, Heinrich Olbers published his famous paradox stemming from the question: "Why is the sky dark at night?" In an infinite universe *with perfect light transmission*, any line of sight in any direction would encounter a star. The night sky would be wholly lit up. Because this is not the case, Olbers, believing in macrocosmic infinity, concluded that dark matter between the stars caused the darkness of the night sky. However, as recently as 1984, some believers[338] in perfect light transmission still concluded that the dark night sky proves the universe is finite—a classic example of how an erroneous initial assumption can produce an erroneous conclusion.

About a century after Olbers, Edwin Hubble discovered the galactic redshift. Although Hubble himself initially abhorred the idea, others used his data to conclude that the universe was expanding. For some of the most enthusiastic believers, this was the true resolution of Olbers's paradox.[339] An expanding universe, even if somehow infinite, would also be dark at night, they say. John Eber, one of the few early opponents of the Big Bang Theory, nonetheless pointed out that:

> The night sky is dark because of the red shift, not because of an expanding Universe. Whatever the cause of the red shift, its existence makes Olbers's paradox redundant. Can we now give the paradox a decent burial? It is of no value as a witness for expansion, or for a finite Universe.[340]

In their uncritical acceptance of wave-particle dualism, Big Bang advocates logically also must accept the supposition that light can be transmitted perfectly. But there is no known precedent for the perfect transmittance of any thing or any motion. In fact, any universe without perfect light transmission would have a dark night sky (Table 8-1). As Eber implied, unless you are an idealist, Olbers's paradox is useless for distinguishing between infinity and finity.

Scientists ordinarily do not overlook such simple logical errors without a deep-seated, dogmatic philosophical reason for doing so. Expansionism, wave-particle dualism, and the Big Bang Theory itself are by now integral parts of the structure of systems philosophy. An attack on one is, in effect, an attack on the others. Mere mention of the ether is met with extreme derision. Actual measurements of the ether's properties are ignored. It will take much more than pointing out a few symptomatic slips in logic or inconvenient data to dump the Big Bang Theory. Nothing less than a new theory of light will be required.

Whatever the details of that theory may be, one thing is certain. To put the macrocosm back into its proper place in electromagnetic theory, a return to some form of the ether is necessary. Early concepts of the ether had their faults, but even so, they enabled Frederick Engels, writing over a century ago, to anticipate the univironmental explanation of the redshift:

> If the ether offers resistance at all, it must also offer resistance to light, and so at a certain distance be impenetrable to light. That however ether propagates light, being its medium, necessarily involves that it should also offer resistance to light, otherwise light could not set it in vibration.[341]

As long as wave-particle dualism reigns, however, the ether will remain superfluous. The unprecedented wave-particle will continue to travel through "empty space" unhampered, giving up none of its motion or matter as it does so. Only such a beast could bring back testimony that its altered condition is only a result of the Doppler Effect and that it did not bump into anything on the way. There *has* been establishment resistance to such nonsense. P. A. M. Dirac, the famous physicist, once outlined the alternative: "We may very well have an ether, subject to quantum mechanics and conforming to relativity, provided we are willing to consider the perfect vacuum as an idealized state, not attainable in practice."[342]

Such heretical thinking was completely ignored. The stripping of the macrocosm to make way for the wave-particle theory logically required, as we have seen, a similarly systems-oriented theory of gravity. With space being totally empty, even the mysterious "pullers" that some resorted to in the attraction hypothesis became untenable. Although space had been dematerialized, Einstein found it mathematically possible to attribute curvature to "it." And why not? It was the only way left to explain gravity.

The systems theory of light and the systems theory of gravity quickly showed their intimate heritage. Massless wave-particles supposedly traveled in perfectly straight lines through perfectly empty space. If this were true, any deviation from a straight line would mean that space itself was curved even though space was thought to be the complete absence of matter. The first evidence thought to support this fantasy was Sir Arthur Eddington's celebrated "observation" that the path of light from a distant star is curved by its passage near the sun.[343] But as Paul Marmet[344] pointed out, there is no way that the tiny value reported by Eddington (1-arc-second) could have been meaningful in the face of the usual atmospheric disturbances amounting to 2-or 3-arc-seconds (as in the twinkling of stars).

Microcosmic thinkers interpreted Eddington's claim to mean that "the sun by its presence curves the space around it."[345] It was almost as if old Sol, by himself, could embrace light beams as they passed through the nearby vacuum. In the anthropocentric spirit of the traditional belief in gravitational attraction, systems philosophers managed to make even curved space a property of the microcosm. Few had the temerity to ask how supposedly immaterial space nevertheless is capable of being bent like a material object.

Light probably *is* deflected near massive celestial bodies, despite Eddington's inability to measure it, but it is no evidence for General Relativity and the curvature of "empty" space. The properties of ether no doubt vary throughout the universe. The bending of light near large astronomical bodies would demonstrate the presence of an etherosphere just like the one shown for Earth (Fig. 8-2). The transmittal of matter and the motion of matter through anything but ideal empty space could not be a perfectly straight-line affair. All microcosms are influenced by other nearby supermicrocosms. Indeed, as asserted in the Univironmental Theory of Gravitation, many of these supermicrocosms are necessary for maintaining the integrity of the microcosm in the first place. They are, so to speak, the *pushers* that are required to hold the microcosm together. Without these pushers, microcosms—photons and gravitons included—would literally explode into the "empty space" of the macrocosm, flying apart in all directions.

As described in the Univironmental Theory of Gravitation, the flight path of a microcosm is bent whenever its macrocosm is not perfectly isotropic. This is particularly significant whenever there is a pronounced flow of supermicrocosms impacting perpendicular to the direction of travel, as is the case in the gravitational shadow cast by an especially massive nearby object such as the sun. Had Eddington been able to measure it, he would have found that the sun shields one side of the interacting photons from the full complement of these supermicrocosms. Like other microcosms, the photons are deflected toward the side of the macrocosm providing the least resistance. Instead of following a perfect right line, the flight path of the photon is bent toward the nearest and most intense gravitational shadow. For passage near the sun, this results in a sort of mega wave in the path through which the motion is transmitted from photon-to-photon.

The univironmental transmission of light motion must be highly efficient, but it cannot be perfectly efficient; there must be losses of motion along the way. The particles that make up the ether, whether they be photons or some other kind of microcosm, must absorb and emit motion and require supermicrocosmic bombardment for the maintenance of their integrity. Eventually, the electromagnetic motion from distant galaxies must be absorbed by the microcosms involved in its transmission. Eventually, it must become so weak as to be undetectable. We know that all wave motion is shifted to longer wavelengths during transmission. The galactic redshift is just what we would expect.

Theory of the Infinite Universe

In criticizing the popular scientific literature supporting the Big Bang Theory, Eber pointed out, "There are two logically possible but mutually exclusive basic explanations for the existence of the Universe. It either had a beginning, or it did not."[346] In his opinion, "the Universe had no beginning, and is consequently infinite in spacetime." He goes on to note that "If we proclaim an antiscientific

Cosmology, all other fields of intellectual endeavour must soon become contaminated by it."

Agreed, except that the contamination is not about to begin; it is and always has been an integral part of the history of intellectual development. Is it any wonder that when we partake of a lunch of chaos, attraction, curved space, and wave-particle dualism we end up with a Big Bang?

There is, then, only one possible general replacement for the Big Bang Theory—the Theory of the Infinite Universe. The univironmentally based theories outlined above suggest what the infinite universe is really like. No portion of the infinite universe is completely empty, just as no portion of it is completely filled with solid matter. Convergence and divergence within this universe are equivalent. There can be no grand divergence or grand convergence of the universe as a whole, an expanding or contracting infinite universe being out of the question. It is not a steady state universe—there is nothing steady about it, for everything within it is in motion. It is not an evolutionary universe, for that word cannot be applied to an infinite universe; evolution is motion, and an infinite universe, by definition, does not move with respect to anything else. It is not a reversible universe, for no microcosm within it ever has an identical relationship with the macrocosm at any two moments. It is the only universe compatible with Univironmental Determinism.

It is almost as if the universe were both expanding and contracting at the same time. Microcosms diverging from one place are at the same time converging on another place. For any particular microcosm, birth comes about through the convergence of its submicrocosms, and death comes about through their divergence. Because both the microcosm and the macrocosm are in constant motion, both birth and death are inevitable. The concept of immortality applies only to the universe as a whole; it cannot apply to any portion of it.

Birth and death, convergence and divergence, can be illustrated in the relative motions of any microcosm and its macrocosm. We now realize that there is no particular microcosm or general class of microcosms whose coming into being and passing away could be objectively considered more fundamental than that of another. The evolution of the hydrogen atom is as important as the evolution of the galaxy. Galaxies, however, have received the primary emphasis in the Big Bang Theory and thus deserve some discussion.

Astronomers have discovered that galaxies decelerate as they diverge from one another.[347] While the deceleration is usually interpreted as a result of gravitational attraction slowing the effects of the Big Bang, it is also to be expected in an infinite, nonexpanding universe. The deceleration of galaxies, in fact, provides an important clue to their origin as well as their fate.

Newtonian mechanics says there are two ways to decelerate a body: 1) by transfer of motion to another body through contact, and 2) by "attraction." Big Bang theorists, for all their braggadocio about rejecting classical mechanism, characteristically ignore the first, which they know full well to be valid, while promoting the second, about which even Newton had doubts. Our original assumption of *complementarity*, of course, left no room at all for the hypothesis of attraction. Whenever two bodies moved toward one another, this was assumed to be a result of inertial motion produced by collisions with or "pushes" from other bodies. And as the Univironmental Theory of Gravitation showed, attraction also is no longer necessary in the place where Newton was forced to call on it three centuries ago. From the mechanical as well as the univironmental point of view, every deceleration must be accompanied by acceleration. Attraction is superfluous.

The question logically arises: "if galaxies decelerate as a result of collisions, with what do they collide?" A generalized answer was alluded to in the above univironmental explanations. Galaxies collide with and accelerate supermicrocosms in the intergalactic sea, which is a veritable zoo of microcosms, multitudes of particles of infinite variety. These microcosms in the intergalactic regions no doubt are similar to, and no doubt include, many of those we have already detected in interstellar space.[348] A microcosm as complex and wonderful as a galaxy surely must have an equally rich macrocosm.

The galactic microcosm, we assume, is much like all other microcosms, and it is on that basis that I offer the following speculations. For a galaxy to come into existence, a certain portion of the universe must absorb more matter and/or motion—of a particular type—than it emits. For it to go out of existence, it must emit more matter and/or motion—of a particular type—than it absorbs. Deceleration and electromagnetic emission are evidence of divergence—the old Second Law of Thermodynamics at work. Acceleration and electromagnetic absorption are evidence of convergence—*complementarity* at work.

As noted before, there is always a difference in the relative motion of a microcosm and the supermicrocosms in its corresponding macrocosm. If the motion of the galaxy is greater that of its surrounding intergalactic sea, the galaxy will be decelerated and the intergalactic sea, as a whole, will be accelerated. Just as the passage of a spacecraft leaves a trail of hot air as it traverses the earth's atmosphere, so too must the galaxy leave a trail of microcosms that have absorbed some of its motion. Both the spacecraft and the galaxy are decelerated as a result of univironmental interactions with their respective macrocosms.

As we learned in the section on neomechanics, the transfer of motion from a microcosm to its macrocosm not only causes deceleration of the microcosm as whole, but it also causes the submicrocosms within to move more slowly relative to their surroundings. And because mass is a reflection of these internal motions, the mass of a galaxy decreases as it radiates. The submicrocosms within slow down relative to the macrocosm, transferring motion and/or matter to the macrocosm. The galaxy contracts. As its volume decreases, its density increases, even though its overall mass must be less than before deceleration, radiation, and condensation. Like all other microcosms in the universe, the galaxy eventually loses its battle with the macrocosm, transmitting more and more motion to it until, at last, it becomes indistinguishable from the macrocosm itself.

The dying motions of one galaxy are the birth pangs of another. Microcosms in the intergalactic regions are continually bombarded by other microcosms. Particles that form the ether collide with each other and with all manner of particles in this intergalactic zoo. The "lost" motion that Asimov complained about is not lost in "empty space," but absorbed internally by the microcosms in the intergalactic sea. The internal motion of the submicrocosms within these microcosms increases with each accelerating impact. It decreases with each decelerating impact. These microcosms expand and contract, and their mass increases and decreases. Eventually, some of them absorb so much matter or motion and gain so much mass that they become something greater than what they were. The new microcosms thus generated combine with other intergalactic microcosms to form still greater microcosms. This is by no means a *creation* from nothing—the infinite regress of smaller and smaller microcosms has always existed even though any particular microcosm has not.

Some of these combinations no doubt produce electrons and protons, the building blocks of the atom. Like all other microcosms, these too are subject to the gravitational bombardment that tends to push them together. The less massive electron ends up orbiting the more massive proton in a mutual shadow-casting arrangement we call the hydrogen atom. Hydrogen atoms, in turn, are pushed toward each other, forming great clouds that condense into stars.[349] Then, the more familiar thermonuclear reactions occur with the emission of great amounts of motion as convergence continues.[350] Under high pressures and great temperatures, electrons are pushed ever closer to the protons they orbit, eventually combining as neutrons. Next, two protons and two neutrons combine, casting a mutual gravitational shadow with two electrons in orbit instead of one; helium arises. Through similar processes, the grand convergence continues, producing the heavy elements that are the constituents of the things most familiar to us.

The Theory of the Infinite Universe sketched above is in some ways similar to the "steady-state theory" or "continuous creation theory" proposed by Bondi and Gold[351] and Hoyle.[352] For instance, Fred Hoyle believed, "Intergalactic space is a place of great activity … a place in which galaxies are constantly being formed … This picture is entirely different from that presented by the other cosmologies, in which intergalactic space is a dead region in which little or nothing is supposed to take place."[353]

To their credit, the steady-state cosmologists stress these all-important reactions in the regions between the galaxies, while the Big Bang theorists have mostly ignored them or tried to include them within the "first few seconds" of their originating universe.[354] Lately it has been fashionable to look to the heavens for "dark matter." If there isn't enough, the universe is supposed to expand forever; if there is too much, it is supposed to stop the expansion via the microcosmic "pull" of gravity. Whether or not it is ever adequately detected, there surely is just the right amount of matter to prevent an expansion or contraction, as those terms do not apply to an infinite universe.

To their discredit, the steady-state cosmologists accepted the interpretations of the expansionists and, in doing so, were forced to hypothesize the creation of matter out of nothing. The indeterministic rejection of *infinity* had led to another absurdity, the rejection of *conservation*, a much more popular assumption among Western scientists. To be sure, the violation of *conservation* was not supposed to be much—the equivalent of one hydrogen atom in each liter of space every 500 billion years. But for those who could accept a small amount of ***creation***, another problem arose. To be consistent, expansionism also required an acceptance of the view that the galaxies are decelerating. If the "pressure" of the creation of matter out of nothing was responsible for the expansion, one had to conclude that the creator was losing its powers with time. Most cosmogonists found it preferable instead to get the work of creation done at the "beginning" where the violation of *conservation* would be a onetime affair and thenceforth cease to be bothersome.

The infinite universe, of course, poses no threat to *conservation* because it requires it. Although it may be beyond our finite abilities to comprehend it, the infinite universe had no beginning and will have no end. The deceleration of galaxies and of other microcosms that move between them results in the acceleration of other already existing microcosms. Each of these accelerated microcosms in the infinite regress absorbs some of the motion of impact internally, in the univironmental way. The relative increase in internal motion of already existing submicrocosms is measured as a relative increase in mass. In no way can this be construed as a creation of matter out of nothing, but must be considered the transformation of one kind of motion of matter into another. It represents a special case of reactions we see all around us. In an infinite universe, microcosms cannot diverge from each other without converging on still other microcosms. The dance of the microcosms has no beginning and no end.

Requiem for the Cosmogonic System

The myth of the Big Bang origin of the universe symbolizes the profound crisis enveloping twenty-first-century science. Indeterminism has had its way. The skeletons of religion play with the finest minds, manipulating them toward their own ends. The public must endure tales of chaos and heat death—stories that must seem to many like threatening sermons or the ravings of madmen. After three centuries, Newton's misgivings about action-at-a-distance remain unheeded. Ironically, light from distant celestial objects blinds indeterministic astronomers to the magnitude and the majesty of the universe. The only solution to the crisis is, as always, a return to determinism.

The renaissance requires a revision of our ideas of why things happen: an end to the myths of heat death and chaos, attraction, curved space, and wave-particle dualism. We no longer need the salvation proffered by the notions of divergence without convergence, magical action-at-a-distance, and the perfect transmittal of light. A few lies have agglomerated. The attempt to dispel any one of them is invariably met with what at first appears to be unreasonable resistance. But this is to be expected because, being founded on similar assumptions, these notions are all parts of an interconnected theoretical structure. It now becomes virtually impossible to reject its most outrageous creation without giving up systems philosophy as well.

Chapter 9

The Origin of Life

> What a victory, gentlemen, for materialism if it could be shown that matter can organize itself and come to life. Ah! if we could give (to matter) that other force which is called life … what need to resort to the idea of a primordial creation, before whose mystery one must indeed bow down? What need for the idea of a God creator?[355]

Science has pushed the notion of special creation farther and farther into the past. The theory of the Big Bang origin of the universe is the last step in preparing us for the grand finale: the rejection of the creation hypothesis altogether. To its credit, the Big Bang Theory seems to have diverted indeterministic attentions, allowing safe passage for the scientific study of *biopoesis*, which is the process by which life originated from inanimate matter. While cosmogonists were banging away, molecular biologists were quietly working out the answers to that other great question of origin. No longer must we despair, as Darwin did in the last century, "It is mere rubbish to talk of the origin of life; one might as well talk about the origin of matter."[356]

And neither must we pay homage to indeterminism in the unseemly manner of *The Origin of Species*: "There is a grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one."[357]

Nowadays, scientists in progressive countries speak freely of biopoesis, unencumbered by demands to consider the indeterministic alternative. In the United

States, of course, biopoesis generally cannot be taught in elementary schools and it seldom receives more press than theories favorable to religious notions. I include this chapter on biopoesis to fill this pedagogical gap and to show the evolutionary transition between cosmochemistry and biochemistry.

History of the Theory of Biopoesis

Not only do beginning assumptions restrict *how* we think about the world, they also restrict *what* we may think about it. For the believer in ***creation***, the origin of life from inanimate matter is a nonproblem—it is unthinkable. As always, any pretense to scientific thinking ends where the belief in the supernatural begins. Thus, biopoesis only could be discovered by scientists who rejected ***creation***. In direct contrast to today's cosmology, the story of biopoesis begins with atheists and reds, instead of priests and whites.

Frederick Engels was among the first to suggest that life originated from inanimate matter. In Engels's view, it was simply in "the nature of matter to advance to the evolution of thinking beings … wherever the conditions for it are present."[358] Engels unfortunately provided few details of the conditions or the steps involved, and the credit for the modern theory on the origin of life generally goes to A. I. Oparin[359] of the former Soviet Union and J. B. S. Haldane[360] of Great Britain. It is not a coincidence that all of these men also were familiar with dialectical materialism.

Engels was greatly influenced by Friedrich Wöhler's synthesis of urea (an organic chemical) without the aid of living organisms. Although this produced no animation, it was an important first step: the manufacture of elementary chemical building blocks associated with the biological mechanism. Engels interpreted this as evidence for his developing belief in *interconnection*. If there was an easy transition between the inorganic and the organic, then there ought to be one between the nonliving and the living. The prediction rang true. Subsequent observations of viruses and other combinations of the chemical compound peculiar to all life forms on earth—deoxyribonucleic acid (DNA)—showed that the distinction between the living and the dead often can be decided only by arbitrary definition.[361]

Dialectical materialists pictured life originating through a series of steps of increasing complexity, inevitably leading up to the living state, although they did not know exactly *why* this should occur. As recently as 1968, Oparin modestly ventured that "the transition from stage to stage from one 'form of the motion of matter' to another is brought about by 'natural selection' which applies in a way to nonliving as well as living systems."[362]

Others have toyed with the possibility that natural selection somehow also occurred among prebiotic chemicals,[363] but for the most part, the idea has been rejected. This was supposedly because "natural selection itself seems only possible in systems having a complexity corresponding to at least that of the proteins."[364] This reluctance is understandable in view of the traditionally narrow way in which natural selection has been defined as a characteristic only of biological systems. As we have seen, to make the mechanism of evolution more inclusive would be to make it more philosophically distasteful to our ever-present indeterminists. Even so, investigators continue to call for "some theory which would help us understand how an evolving aggregate of organic chemicals would move toward the self-replicating state."[365]

As I implied in an earlier chapter, natural selection, and especially its combination with genetics in neo-Darwinism, must be considered useless for this purpose because biopoesis is the study of the transition from the nonbiologic into the biologic. To explain that transition we obviously require a more general mechanism applicable to both realms.

We still await such a mechanism. Systems philosophy, while often making gallant attempts to bridge the gap between disciplines, has managed little more than resignation over the subject. There are two primary reasons for this. First, as mentioned previously, systems philosophy is plagued by the assumptions of ***finity*** and ***certainty***—leftovers from classical mechanics. In classical mechanics, the conditions required for a particular effect were considered finite in number. Since the number of conditions is actually infinite, the only way to preserve ***finity*** is to lump all the less important conditions under a singular cause: chance. In regard to biopoesis, this heritage typically yields comments like this: "The evolution of life on Earth is a product of random events, chance mutations, and individually unlikely steps … We are the products of a series of biological accidents."[366]

This quasi-Aristotelian view, that biopoesis is unlikely rather than likely, persists despite plentiful demonstrations to the contrary. In biopoesis, as in other processes, a particular step is "individually unlikely" only when it is viewed in the way those words suggest: from the perspective of systems philosophy. Isolated from its necessary context—that is, from its surroundings—a particular step in biopoesis is not only unlikely, it is impossible. This is because, as I intend to demonstrate, biopoesis is above all a univironmental interaction, not a systemic one.

A protein consisting of a chain of 100 amino acids is necessary for life as we know it. According to Shklovskii and Sagan, the probability of such a thing being produced completely at random is something on the order of 1 in 10^{-30} (i.e., 0.000000000000000000000000000001).[367] But all such calculations are meaningless, merely being dependent on the degree to which one considers each step to be isolated from all the others. Perfect isolation, after all, would allow no interaction whatsoever. To be logically consistent, probabilities calculated from a strictly systems point of view should all be zero.

In the same way, I can be assured of never having an "accident" with my automobile if I never drive it where it might come in contact with anything else. Unforeseen events do not occur to microcosms that do not interact with the macrocosm. If I drive my automobile, there is no telling what I might run into, but each obstruction that might contribute to my destruction exists where it does at the time it does because of an infinite series of events. Each event leading to the existence of a particular obstruction occurred because it was the only possibility under the univironmental conditions that produced it. No part of the universe forms by accident. Likewise, from the deterministic point of view, biopoesis is by no means an accident or a random event, but the only possible result of certain changes in the univironment. Although there is much to be learned about the origin of life, biopoesis no longer need be described by chance, which is, after all, just another word for ignorance.

A second reason that systems philosophy has difficulty discovering the causes of biopoesis also derives from its inherently microcosmic point of view. This is reflected in the terminology used by modern systems philosophers to describe the reactions they study. Ordinarily, the best scientists try to avoid terms that smack of *teleology*, the doctrine that design is apparent or ends are immanent in nature. Allusions to teleology are remnants of *vitalism*, the quasi-religious belief that the processes of life are not exclusively determined by mechanical causes but are directed to the realization of certain normal wholes or entelechies. For decades it has been fashionable to apply the prefix "self" to convergent reactions ascribed to living systems, with it being especially prevalent in descriptions of biopoesis.[368] For the systems philosopher-neovitalist, it is a no-brainer: "the complex molecule assembles itself."[369] This reconstituted *neovitalist* movement is already in an advanced stage of development. First principles already have been established in biology[370] and they show every sign of permeating physical chemistry too. Nicolis and Prigogine, for instance, immortalized neovitalism in the title of their book, *Self-organization in Nonequilibrium Systems*.[371] More recently things have gotten a little out of hand. Neovitalism has morphed into what the creationists call "intelligent design."[372]

Before Prigogine's era, this kind of terminology was rare in descriptions of reactions in inorganic chemistry.[373] In the past, the "self" was not fully realized in evolution until the nonliving became the living. But, if one may pardon the expression, the use of this appendage for describing biopoesis is "self-defeating." The microcosmic connotations of the word "self" do not allow proper consideration of the macrocosm, which is what is wrong with systems philosophy in general and studies of the mechanism of biopoesis in particular.

Very few chemists would argue against the univironmental nature of nonbiological reactions. Most would probably agree that the reactions undergone by a particular compound are determined by the motions of matter within and without. But when the reactions become "biological," scientists are apt to reject the deterministic, univironmental approach. It is as if, subconsciously, they see their own reflections in the reactions and then feel compelled to describe them in anthropocentric terms.

Within the field of biopoesis, thermodynamicists seem the worst in this respect. Their assumption of ***noncomplementarity*** for the Second Law of Thermodynamics (SLT) leads down the slippery path to neovitalism. As we have seen, interpreted from the microcosmic point of view, the SLT ultimately favors destruction over construction. And because biopoesis is so highly dependent on convergence from outside the system, today's thermodynamicists readily attribute unseen univironmental effects to the microcosm itself. Ignorance of the macrocosm is transformed into a modern but still uncaused "vitality," which is otherwise known by many other names and is the be-all and end-all of indeterminism. Thus it is only natural for thermodynamicists to make microcosmic mistakes, to overemphasize the microcosm and to look on the origin of life as a self-assembling or self-organizing process. But until they adopt univironmental thinking, they will be unable to understand the fundamentals of biopoesis.

Conditions Required for Biopoesis

Before I discuss the univironmental mechanism by which life inevitably originates from inanimate matter, let us review what is already known about the necessary conditions. These have been investigated and expounded in detail since the '20s by numerous authors expounding on "The Origin of Life."[374] Briefly, the earth's environment during biopoesis was roughly as follows:

1. Earth surface temperatures between 10 and 40 degrees Celsius because of its distance from the sun;[375]
2. Existence of free water[376] exhaled from volcanoes and geysers;[377]
3. Absence of free oxygen in the atmosphere due to the absence of plants;[378]
4. Presence of a large amount of shortwave ultraviolet radiation from the sun;[379]
5. Presence of carbon, hydrogen, oxygen, and nitrogen[380] exhaled from volcanoes;
6. Presence of various essential minor elements and trace elements;

7. Fluctuations in the univironment; and
8. An infinity of additional factors, most of which were insignificant.

Research continues in further delineating the conditions that were specifically required for biopoesis on the earth. At the same time, there is increasing interest in defining the broad range of conditions required for biopoesis elsewhere in the universe.[381] Some believe that other elements—silicon, for example—might serve as analogues of our own carbon-based system, while others believe carbon to be the only one capable of forming enough side chains for the required complexity.[382]

Life as we know it arose through a specific chain of events that will never be repeated exactly nor documented with perfect precision. Nevertheless, biopoesis undoubtedly occurs under a relatively wide range of varying conditions. In fact, a non-fluctuating environment is the only condition that, theoretically, could prevent biopoesis. As David Hawkins observed, "Life would be a miracle if it appeared in a world of thermal equilibrium."[383] Indeed, a world of thermal equilibrium itself would be a miracle. The study of biopoesis is forcing us to view the nonliving as well as the living as nonisolated systems that never attain the sort of equilibrium idealized in the conventional thermodynamic model.[384] The microcosm and the macrocosm are in constant motion, forever pushing microcosms toward a univironmental equilibrium that by its very nature must be temporary. *Inevitably*, there arises a special kind of complex motion: life.

Biopoesis by Means of Univironmental Determinism

Why does biopoesis occur? To the systems theorist, life may be the result of "accident" or of "self-assembly," but to the univironmental determinist it is, like cancer, the only possible response to certain conditions. As H. F. Blum so uncharacteristically put it, "In chemical evolution, choice of the chemical species that will be formed must depend both on the properties of the reactants and the milieu in which they find themselves."[385] In other words, like all other motions, biopoesis occurs through the mechanism of evolution, Univironmental Determinism.

Below I give a few extremely simplified reactions that illustrate how life originates by means of Univironmental Determinism. These are all hypothetical, but they demonstrate the basic principles. While reading this, please be reminded that the origin of life on an amenable planet and the origin of cancer within an amenable body have much in common.

Suppose we have two inorganic compounds, A and B, that undergo the following reaction at the surface of the earth as it is warmed by the sun during the daytime:

$$A + B + kcal \xrightarrow{25^{o}C} AB \quad (9\text{-}1)$$

Microcosm A is an inorganic compound surrounded by a macrocosm that includes inorganic compound B and other supermicrocosms (such as photons) capable of transmitting motion (kcal) to the reactants. Likewise, the microcosm of B is surrounded by a macrocosm that includes compound A. The microcosm of A includes all that matter within A (electrons, protons, neutrons, etc.). Ditto for the microcosm of B, although it is somewhat different from A. A and B come in contact through inertial motion brought about by impacts from the macrocosm which pushes them toward each other to form the compound AB. The reaction proceeds because AB is more stable at 25ºC than are mixtures of A and B. That is, for this particular univironment, there is less motion of matter after the reaction than before the reaction.

Now suppose the macrocosm changes; the rotation of the earth results in darkness and the temperature drops to:

$$AB \xrightarrow{20^{o}C} A + B - kcal \quad (9\text{-}2)$$

AB was the microcosm that was stable for its univironment at 25ºC, but since the macrocosm has changed to 20ºC, there are fewer impacts on the microcosm of AB. There are no longer sufficient impacts to keep AB together. Decreased motion within the macrocosm allows the submicrocosms, A and B, to diverge from one another under their own inertial motion. Univironmental equilibrium now means divergence rather than convergence for compounds A and B, detachment rather than alliance, fission rather than fusion.

In idealistic terms, once univironmental equilibrium has been achieved, there is no more reaction. Of course, when the univironment changes again, a new reaction occurs. This always happens because reactions move toward the *least* amount of motion for the univironment, rather than toward the fictional state of *no* motion. In this example, the earth will continue to rotate and the temperature will change again.

If there had not been a change in the macrocosm following the initial formation of compound AB in reaction 9-1, AB would have remained as compound AB and nothing resembling life could have arisen. But this itself is impossible; nothing is forever. Consequently, there is a seventh condition, the most important, which must be met before biopoesis can occur: there must be fluctuations in the univironment. This was recognized, after a fashion, by Lahav and others. "Fluctuating environments provided a favorable geological setting in which the rate and extent of chemical evolution would have been determined by the number and frequency of cycles."[386]

In a strict sense, of course, this is incorrect. A fluctuating environment, by itself, would not produce life. Reactions 9-1 and 9-2 could alternate between day and night forever without producing life. Unless a cyclic pattern is progressive—that is, unless no two cycles are perfectly identical—evolution could not occur. This is where *infinity* comes in.

How is it that all real cycles are never repeated exactly the same way twice? As assumed under *irreversibility*, each cycle is produced by an infinite set of causes. Only a finite set would be exactly repetitious. And for a finite set to exist, it would have to correspond to phenomena occurring in perfect isolation from the rest of the universe. No such possibility exists; in an infinite universe every microcosm is subject to the influence of still other microcosms. Determinists in the Laplacian tradition obviously would have trouble explaining biopoesis.

Up to this point in this simple illustration, we could list our "causes" for biopoesis as the earth, sun, A, B, AB, and photons. Such a list, of course, is finite, an isolated system, a closed loop. It may be a good beginning, but if these are the only "causes," then there are absolutely no prospects for evolution beyond this point. Without the inclusion of some other factors, some other microcosms entering from the macrocosm, the prospects for life would be zilch.

You have only to look up at the clear night sky to see thousands of stars, each having emitted the motion that causes photons to impinge upon your eyes. This visible radiation is only a tiny portion of the cosmic radiation to which we are subject. The earth is daily bombarded by subatomic particles derived from outer space. Of those recognized so far, about 79 percent are protons (hydrogen nuclei), 20 percent are alpha particles (helium nuclei), and the remainder are nuclei of carbon, nitrogen, oxygen, and other elements of atomic number greater than ten.[387] Our present atmosphere interacts with 99.95 percent of these particles, producing secondary cosmic radiation involving photons, neutrinos, pions, muons, and electrons that subsequently affect the earth's surface.

The earth's primitive atmosphere had little oxygen and was different from the present atmosphere in many respects, but it was similar in one major respect: cosmic radiation was a "fact of life." According to *infinity*, there is a continuous flux of incoming microcosms bombarding everything in the universe. Even the center of the earth is not isolated from radiation. Neutrinos, for example, are so fast and so small that most of them travel completely through the earth. Thus, it is impossible for reactions 9-1 and 9-2 to alternate for long before some kind of unprecedented radiation becomes a significant part of the macrocosm of either A, B, or AB.

Suppose, for example, that compound AB is hit by a converging microcosm, here represented by X, which could be, for example, a photon having the kinetic energy associated with the ultraviolet frequency,[388] an electron supplied by an electrical discharge,[389] or an atom of a heavy metal or other element:[390]

$$AB + X + kcal \rightarrow AB^* \quad (9\text{-}3)$$

During the reaction, compound AB undergoes two or more of the six possible neomechanical interactions that can occur between microcosm and macrocosm (chapter 5). If the convergent velocity of X is greater than that of AB, as is usually the case, AB will be accelerated as a whole. More importantly, it will absorb matter and/or motion internally. The result is microcosm AB*, a compound very similar to compound AB, but dissimilar in ways dependent on the type of interaction undergone with supermicrocosm X. This new combination, this new convergence, at the same time produces a divergence: reaction 9-2 becomes extinct. Reaction 9-2 can never occur again, because microcosm AB* is not microcosm AB. The univironment of AB has changed irreversibly; no longer will compounds A and B form when the temperature drops at night.

Conventional chemistry generally views the sequence depicted by the alternation of reactions 9-1 and 9-2 as "reversible," but in the strict sense they are not. They may appear reversible from the narrow perspective of systems philosophy, but they most certainly are not from the univironmental point of view. Each of these microcosms—A, B, AB, and X—really is, at every moment, in a unique space-time position. As the reactions alternate through a seemingly endless sequence, supermicrocosm X or the motion it will transmit is hurtling from some other place in the universe, perhaps from another star or galaxy, getting ever closer, its relationship to the microcosm of these reactions changing with each passing moment.

Indeterminists might consider the convergence of AB and X as a sort of predetermined or predestined event, or even as a matter of absolute chance. None of these terms is an adequate description, however, because each of them is tainted with subjectivity, while the convergence here is strictly an objective phenomenon. Remember that in an infinite universe, no microcosm is isolated. Microcosm AB is at all times liable to convergence from an infinite number of supermicrocosms arriving from the macrocosm. Supermicrocosm X is not the only one capable of interacting with microcosm AB, although others might produce AB** or some other compound different from AB*.

Now, let us assume that microcosm AB* undergoes the following reaction at night:

$$AB^* - kcal \xrightarrow{20^{o}C} A + B^* \quad (9\text{-}4)$$

A divergence like this is a common response of chemicals to decreases in temperature. The impacts of supermicrocosms from the macrocosm are necessary to hold microcosm AB* together. When these motions of the macrocosm decrease, microcosm AB* expands against the univironmental boundary, transferring some of its motion to the macrocosm. If the temperature is low enough, the expansion is so great that microcosm AB* breaks up. Only a reheating of the macrocosm, an increase in its motion, will force A and B* to converge again.

The evolution of life would cease at this point unless there was yet another factor, another converging supermicrocosm from the macrocosm that could combine or interact with AB*. Invariably, in an infinite universe, there *is* another converging supermicrocosm, take C for example:

$$AB^* + C + \text{kcal} \xrightarrow{25^{\circ}C} AB^*C \qquad (9\text{-}5)$$

In the process, supermicrocosm C contributes some of its motion and matter to AB*, forming AB*C. A subsequent change in the macrocosm, such as a decrease in temperature at night, leads to this:

$$AB^*C \xrightarrow{20^{\circ}C} A + B^*C \qquad (9\text{-}6)$$

Note that in this reaction divergence, not convergence, produced a new combination, B*C. The lesson here is that not all the steps leading to the formation of a complex microcosm are convergent. The overall process must be seen as convergent, but many of the intermediate steps are not.

The reactions above are typical of those producing animate as well as inanimate matter by means of Univironmental Determinism. Each combination of elements was the most stable configuration for the univironmental conditions existing at the time. If it is possible for a reaction to occur to a single member of a class of microcosms, it often will occur for others, given a similar macrocosm. The rate of the reaction depends on how often a similar univironment occurs. Generally this only can be described by the laws of probability, for we can never have enough information to tell *exactly* when a certain type of univironment will occur.

Laboratory workers increase reaction rates by themselves becoming part of the reactions they study. Experimenters contribute to convergence by bringing widely scattered compounds together and observing the results. If a hypothesized reaction does not occur readily, scientists sometimes increase the motions of the microcosms involved, for example by increasing the temperature. At other times, they decrease the temperature, withdrawing motion from the microcosm and releasing new submicrocosms in the manner of reaction 9-6.

Biopoesis through Univironmental Determinism illustrates the reactions that Oparin considered akin to natural selection. If one wishes, one may see competition and cooperation, even the survival of the fittest individual or group in these reactions. Sometimes, univironmental equilibrium means a convergence with some other microcosm. Sometimes it means a divergence into separate microcosms. Whichever occurs is strictly dependent on the motions of matter within the univironment. Because both the microcosm and the macrocosm contain an infinite number and variety of submicrocosms and supermicrocosms, there is always the possibility of a new supermicrocosm converging from the macrocosm to attain a new relationship with the microcosm. This means, of course, that early univironments eventually cease to exist. We observe the fossils and skeletons of microcosms no longer viable because their univironments have changed. Sooner or later, this happens to all microcosms; sooner or later, a divergent or convergent reaction produces death or extinction, not life.

The production of a certain type of microcosm reflects a certain type of univironment. Thus if microcosm AB* evolves in a particular macrocosm—for example, a special environment on the earth—then it may evolve wherever a similar environment is found. For once, Chardin got it right; "Life does not work by following a single thread … It pushes forward its whole network at one and the same time."[391] Thus all other microcosms will be evolving also, being influenced by converging supermicrocosms from the macrocosm.

We can imagine a similar, though not identical, series of reactions occurring at many places on the primitive earth. These give rise to similar compounds—for example, DE*F—that continue their evolution in relative isolation. But this relative isolation, like all isolation, is only temporary, and when it is broken, AB*C and DE*F provide new, more complex macrocosms for each other. Each expands or contracts depending on the nature of the motion of matter within and without. All of the neomechanical interactions (chapter 5) are sure to be displayed. The result of the "struggle" between the two may be a "victory" of one over the other. Or it may be a cooperative standoff in which portions of microcosm DE*F are absorbed by microcosm AB*C or vice versa. In either case, a new complexity inevitably arises and a new, grand step toward the evolution of life occurs.

Contemporary Biopoesis

Creating Life in a Test Tube

It will be only a matter of time before life is "created" in the laboratory. One benefit of this celebrated historical event will be the attention directed toward the relationship between the microcosm and the macrocosm. The complexity of the reactions will be so great that from thenceforth it will be nearly impossible for all but the most naïve to view biopoesis as a "self-assembly" process. No longer will it be possible to view life as "building *itself* up." The process will be revealed as long and arduous, and the experimenter will be involved with this newly evolving life every step of the way.

Some say that the artificial preparation of life cannot be done. Others say it would, in a single act, destroy the belief in a god-creator. The skeptics have abounded ever since the idea was broached. In 1874, Engels chided a prominent scientist of the day by remarking:

> What Helmholtz says of the sterility of attempts to produce life artificially is pure childishness. Life is the mode of existence of protein bodies, the essential element of which consists in continual metabolic interchange with the natural environment outside them, and which ceases with the cessation of this metabolism, bringing about the decomposition of the protein. If success is ever attained in preparing protein bodies chemically, they will undoubtedly exhibit the phenomena of life and carry out metabolism, however weak and short-lived they may be … So long, however, as we know no more of the chemical composition of protein than we do at present, and therefore for probably another hundred years to come cannot think of its artificial preparation, it is ridiculous to complain that all our efforts have failed![392]

Today some people already accept the production of live viruses from inanimate matter as sufficient proof of the creation of life in the laboratory.[393] Still others may be impressed by the culture of live human tissues, even though such tissues die after about sixty cell divisions. The techniques for transferring DNA from one organism to another tend to short-circuit the whole effort through modification of old life forms. In spite of all this, the public seems to be withholding its applause for a demonstration that begins with simpler compounds and ends with a good deal more animation. The day that laboratories produce mobile organisms may be decades off, but it will arrive.

Life on Other Planets

When Giordano Bruno was burned at the stake for his deterministic views, among them was the idea that intelligent life existed on other planets. His last words in defiance of the church were no less farsighted: "The time will come when all will see as I see." Today, even churchmen nervously look to the skies for signs of visitors from outer space. The UFO craze that developed since World War II continues unabated and has been followed by more scientifically grounded popular accounts that list the reasons life should exist on other planets.[394] The church seems nearly powerless to discourage the speculation, although from time to time its pseudoscientific apologists announce that we are all alone.[395]

From the deterministic point of view, the odds in favor of life on other planets approaches certainty with the discovery of each new galaxy, of which there were, in the last estimate, over 100 billion. Dott and Batten speculated that there are 10^{20} (i.e., 100000000000000000000) planets in the universe capable of supporting intelligent life.[396] Some more recent guesses are more modest—about 10 billion or so. Sagan estimated a million possible civilizations in our galaxy alone.[397] Kenyon and Steinman guess that there are about 50 habitable planets within 100 light years of Earth.[398] Even so, UFO buffs may be disappointed. According to Sagan, there would be no more than one visitation to our planet every 10,000 years.[399] Even this appears overly optimistic. Throughout the geological record covering more than three billion years, we have yet to find fossil evidence of even one visit from extraterrestrials. If we were ever honored by such a visit, it seems that they either decided to go back home or that they and their fancy equipment disintegrated without leaving a trace.

Of course, calculations purporting to demonstrate that life must exist elsewhere in the universe must include many assumptions that also can be turned toward indeterministic ends. As we have seen, one method of attacking the universality of biopoesis is to view it as a series of events produced by "absolute chance." Blum, for example, estimates that there were a billion times a billion "choices" required for the development of life on Earth.[400] In this misinterpretation, the "choices" supposedly are between life and no life, rather than between one kind of life and another kind, as proposed by A. G. Cairns-Smith.[401] Miss one turn in the road, goes the logic, and there goes a planet's chances for verdancy. Miss the necessary impact of one incoming microcosm and never receive another. Following this line of thought, Blum turns his guess upside down and calculates the probability of life elsewhere at 10^{-18} (i.e., 0.000000000000000001)—virtually zero. A better demonstration of the alliance between indeterminism and Aristotelianism would be hard to come by.

If, as Univironmental Determinism implies, there are intelligent beings elsewhere in the universe, what would contact between our two civilizations be like? The first proof of their existence probably will be achieved via radio.[402] The prospects of physical contact are much less likely, but thinking on this question has already split into two camps. Carl Sagan held the historically naïve hope that extraterrestrial societies would be benign toward us.[403] Van der Veer and Moerman, on the other hand, appear more realistic. "It seems virtually inevitable that *Homo sapiens* may one day meet his cosmic counterparts: and this would mean the end of human evolution as it has been conditioned by the world we live in … or the final end of man himself."[404]

This, of course, does not mean that there will cease to be intelligent life on earth any more than it ceased to exist in the new world after the arrival of Ericsson and Columbus. Obviously, any species that replaces us must necessarily be more aggressive, more cooperative, more intelligent, more capable, and better adapted to our own planet than we are. Good luck with that!

Cancer

Scientists traditionally have thought of biopoesis as a onetime affair: a stage in the earth's evolution for which there can be no modern analog. Nevertheless, it is becoming clearer that many of the diseases collectively known as *cancer* stem from reactions of the biopoetic type. Given the appropriate substrate—carbon, hydrogen, oxygen, and nitrogen and the appropriate macrocosmic inputs—new life forms inevitably arise wherever the old forms do not destroy them. Because every organism contains the proper substrate and is always subject to convergence from the macrocosm, every organism, if it lives long enough, eventually becomes cancerous.[405] Skin cancer, for example, is virtually assured within the lifetimes of fair-skinned people who are not protected from ultraviolet radiation.

Successful treatment involves the manipulation of cancerous cells and their macrocosms to produce univironments that no longer support that kind of life. "Spontaneous" remission occurs because the univironments that produce a particular microcosm are often similar to those that can destroy it. One kind of radiation may produce cancer, while another kind may cure it. The study of biopoesis, once thought by creationists to be irrelevant, irreligious, and perhaps even life-threatening, has turned out to be an indispensable instrument in the battle against one of our most dreaded diseases.

The Inevitability of Life

Norman Cousins once said, "Infinity converts that which is possible into the inevitable." The infinite universe converts the nonliving into the living in the same way that it accomplishes everything else, by means of Univironmental Determinism, the mechanism of evolution. No longer need we consider special creation by an acausal, immaterial being as the reason for the existence of life. No longer need we view biopoesis as accidental or as a self-assembly process in the way neovitalists do. No longer need we remain ignorant of the special microcosmic and macrocosmic conditions required for the creation of life in the laboratory and the control of cancer and related diseases. No longer need we doubt that throughout the infinite universe the univironment produces the type of motion that contemplates itself.

Chapter 10

The Biological Microcosm

> All phenomena which we study objectively in living beings can be analyzed by the methods of physics and chemistry … [L]ife is not freed from the laws of universal mechanics.[406]

In the most fundamental sense, the motion called life has changed little since biopoesis. Biological microcosms and their macrocosms still interact in the same old way: a change in one still produces a change in the other. Microcosms still move toward univironmental equilibrium, the least amount of motion of the within and the without. There really isn't any other possibility. Univironmental Determinism remains the universal mechanism of evolution.

The relatively simple early life forms became more and more complex, not merely through increases in the length and branching complexity of their carbon chains, but through the development of an intricate web of univironmental interconnections. The sometimes steady, sometimes swift, always irreversible evolution of the biological microcosm repeatedly demonstrated the power of matter in motion.

From the first ambulatory form of DNA to the noblest savage, the biological microcosm, even though constrained by the impossibility of acting independently of the macrocosm, nonetheless was destined to give a different impression. The sensing, the recording of a facsimile of the macrocosm, and the delaying of response produced a microcosm that not only could exist and act in its equally complex macrocosm, but by so doing could be considered *purposeful*. With the biological microcosm, there arose the opportunity for the microcosm to take the credit as well as the blame for univironmental interactions.

Expanding On the Reduction

In mechanist Felix Le Dantec's day biologists were not afraid to write of "the laws of universal mechanics" in ways that left little doubt that their biology began with matter in motion and ended with matter in motion. The reduction of all things, including living things, to forms of matter, and all processes, including biological processes, to types of motion, was the one great contribution of classical mechanics to the life sciences. It is on that reduction that we must build an expansion worthy of the infinite complexity of the biological microcosm.

We must not insist, as did the mechanists, that there could be a finite number of causes for univironmental interactions or that the "laws of universal mechanics" are either finite in number or finite in content. We only need to continue, as biologists have all along, to discover "the main features of the univironment" and the laws relating them. With biological microcosms it is especially obvious that the perspective born of ***finity*** is inadequate. All our work necessarily must be a relative reduction of the infinite reality.

Neither in this chapter nor in the rest of the book will I have enough space to expand adequately on the simple reduction with which I began. To flesh out neomechanics to the extent that it would decently portray a living reality would be an immensely difficult task. My aim instead is to demonstrate that, even in biology, the univironmental perspective is preferable to the systems perspective.

Objections to the Physicochemical Model

The level at which I now apply univironmental analysis to biology may be criticized for being a gross simplification. At the outset let me forewarn that this approach is despised by indeterminists, who generally eschew the application of the physicochemical model to anything with roots or legs. But, as I have pointed out all along, a coherent worldview is clearly impossible without a unification of knowledge across disciplinary lines. Our search for similarities in different parts of the world also requires that we see similarities between such disparate fields as physical chemistry and biology. Those who think, as I do, that this might be a worthwhile endeavor must suffer the inevitable criticism from indeterminists. Before we treat living organisms as physicochemical entities or microcosms, we must be aware of the indeterministic objections.

No unified model of the world would suit indeterminists, not merely because it would be incomplete and unsophisticated, which surely must be granted, but because it would discredit their belief in ***disconnection***. Attempts at unification have been regarded by some of them as dangerous, intransigent, and likely to lead to claims of omniscience.[407] But according to *relativism*, any two portions of the universe can be considered similar in some respects and dissimilar in others. No absolute identities or absolute disparities exist. All dissimilarities are relative dissimilarities and all similarities are relative similarities. There are no absolute ones, as would be required by ***disconnection***. But, based firmly in their ***absolutism***, indeterminists typically deny the connection between microcosms described by physical chemistry and microcosms described by biology. This denial is at base a philosophical one, although a factual one is often claimed for it. Let us examine some examples in which this occurs.

By using the sophistry typical of a modern philosopher of science, Ernest Nagel rejected the application of physical chemistry to biology. "It is logically impossible to deduce the totality of biological laws and theories from purely physicochemical assumptions. In short, biology is not at present simply a chapter of physics and chemistry."[408] Nagel's argument can be analyzed as follows: a) one thing cannot be wholly deduced from another (correct), and thus b) the two are unrelated (incorrect). This is tantamount to the claim that a) advanced chemistry cannot be wholly deduced from chemistry, and thus b) advanced chemistry is not a chapter of chemistry. With this subtle misdirection Nagel attempts to drive a wedge between physical chemistry and biology. His message: a unification of knowledge across disciplinary lines is impossible—at least right now.

More knowledge, however, won't change things much, because chemistry and biology will always have their dissimilarities. The deductive requirement is irrelevant and capricious because, if carried far enough, nothing is deducible from anything else. In the end, Nagel's veiled ***absolutism*** would disallow the inclusion of anything with anything else. *Relativism*, on the other hand, states that perfect identities do not exist; one thing never can be deduced in toto from another. In an abstruse way, Nagel is saying that, in his opinion, physical chemistry and biology are perfectly dissimilar. That is not the case. There will always be aspects of physical chemistry applicable to biology and vice versa. The study of every single thing is a chapter in the study of all things.

The imagined absolute ***disconnection*** between the physicochemical and biological models is widely and uncritically accepted today. The promoters of this view even have derived pseudocriteria by which the important distinctions can be made—their way. A primary feature of most such discussions is the assumption, and the tautological conclusion, that biological microcosms are not also physical microcosms. In typical fashion, H. L. Parsons divides the universe into two categories: the physical and the biological, and concludes that "physical systems are relatively simple, stable, and resistant to change."[409] By implication, biological systems must be relatively complex, unstable, and unresistant to change. The false dichotomy also appears in the work of sloppy ecologists who typically say such things as, "parameters which characterize natural biological systems … exhibit random fluctuations. Consequently equilibrium is not the constancy of the physicist."[410] But as Prigogine showed long ago, "random fluctuations" occur in all types of systems, not just the biological.[411]

In typical fashion we learn that an organism "does not completely share inanimate nature's all-pervading desire for physical equilibrium. Indeed organic activity seems to be guided by the desire to avoid a condition of irrevocable physical equilibrium with its environment."[412] By removing the "desire to avoid" from consideration as a result of physical reality, the organism's behavior appears paradoxical when examined in physical terms. Instead of slowing down, it has the possibility of speeding up in supposed defiance of physical law.

While there are dissimilarities between inorganic microcosms and biological microcosms, both are physical systems. As known by those who have studied both inorganic chemistry and biological chemistry, these generalizations in support of a ***disconnection*** between physical chemistry and biology are meaningless—they assume dissimilarities that simply do not exist.

The study of matter in motion transcends disciplinary bounds. The best scientists, however specialized, are cognizant of the need to work up and down the scale of microcosmic complexity. They freely use both deduction and induction, divergence and convergence, to analyze data and synthesize theories. Intuitively, at least, they know that one part of the universe always has some relevance to another part. Almost as many of the elementary concepts owe their existence to the advanced concepts as the other way around.[413]

This is, for example, what made it possible for August Kukulé to discover the structure of benzene.[414] As the story goes, Kukulé had worked all day trying to come up with a six-carbon configuration that would fit the experimental data, but met with little success. Exhausted, he fell asleep in his chair by the fireside in his office. He dreamt of carbon atoms, carbon groups, and carbon chains, some of which twisted and turned in snakelike motion. Wriggling around, one of the snakes seized hold of its own tail, forming a ringlike shape. He awoke with a start. That was it! Going back to his calculations, he found that the ring structure fit his data almost perfectly.

Below I give some detailed examples to demonstrate the main point of this chapter: *that organisms, like all other microcosms, respond equally to what is inside them and to what is outside them*. Biological microcosms move through the macrocosm, interacting with supermicrocosms, exchanging matter and motion, always moving toward univironmental equilibrium. Like all other microcosms, they take part in the great cosmic dance, diverging from one place, while at the same time converging on another. Organisms are, and always will be, *physicochemical* microcosms, matter in motion, subject to the laws of physical chemistry. This basic belief, held by the classical mechanists such as Le Dantec, stands in opposition to the indeterministic view that slanders the nonliving microcosm as inferior.

The Concept of the Refugium and the Law of Mass Action

The living, breathing microcosm emerges from the primal ooze, expanding in all directions. Supermicrocosms from the macrocosm contribute matter and motion to the microcosm, adding to the conflagration of life. But where the univironmental boundary holds, the thing is kept in check. The infinite universe gives life, controls it, and takes it away.

All microcosms have a center, a place of refuge from which the motions of the macrocosm are least destructive. All microcosms have a univironmental boundary, the place where the macrocosm exerts its influence first, and the place where disaster must be endured and success achieved. Because all microcosms exist within the macrocosm, none are alone; all are subject to the motions of the others. All expand and contract, controlling each other in multitudinous ways. For each microcosm there is sun and there is storm. For the biological microcosm, the center, too, acts as a refuge from the storm.[415]

Each species of plant or animal originates somewhere, in a particular univironment where microcosm and macrocosm produce a particular form of matter. What is successful within a particular macrocosm is often successful in a similar macrocosm. If the spreading microcosm encounters still another similar macrocosm, it will continue to grow. Eventually, however, the macrocosm becomes dissimilar. It becomes inhospitable to a particular microcosm, exhibiting a kind of motion no longer suited to the existence of that microcosm—at least not without a few changes.

Biologists have developed an important concept that nicely illustrates this basic nature of biological microcosms. The idea grew out of observations of changes in plant and animal distributions produced under climatic stress. The geological record showed a great retreat of many plants and animals to warmer regions as a result of rapid climatic changes that occurred during each advance of the Pleistocene continental glaciers.[416] Organisms accustomed to warm weather withdrew into refuges or "refugia," tiny pockets of survivors that eventually either died out or flourished after the ice melted. The warm weather allowed their expansion toward the melting ice where the cold weather organisms were forced to retreat to higher latitudes and higher elevations. Today, many mountain ranges surrounded entirely by desert serve as refugia for isolated stands of conifers and other cool-weather plants that once covered the desert below.

The concept of the refugium, discovered in historical ecology, has wide significance because all species may be considered at any time part of a refugium. Any individual is part of a group from which it draws sustenance. A clump of trees is a refugium because the univironmental conditions that produced it are limited. The clump is not a forest, whether it is because of the slashing axe, the invading marsh, or warming slopes of a desert mountain. No one form of life or non-life fills all corners of the universe because there is always something else already there. This fact is driven home when that something else invades the territory of the biological microcosm, causing it to seek refuge.

Not coincidently, chemists also have developed an important idea analogous to and encompassing the concept of the refugium: the Law of Mass Action. The law is illustrated in the following equation:

$$CaCO_3 \Leftrightarrow Ca^{2+} + CO_3^{2-} \quad (10\text{-}1)$$

$CaCO_3$, limestone, is a chemical combination of calcium and carbonate ions that acts as a refuge, so to speak. When a certain type of macrocosm intrudes on any microcosm containing Ca^{2+} and CO_3^{2-}it pushes them together. As their confinement increases, they tend to form solid calcium carbonate. As the macrocosm relaxes, the number of Ca^{2+} and CO_3^{2-}ions in the solution increases. Beginning at the surface of the crystal or "refuge" of solid calcium carbonate, the combination tends to dissolve in water. The solid form is not inherently more stable than the solution form—it simply depends on the environment in which it exists.

There are, of course, innumerable reasons for changes in Ca^{2+} or CO_3^{2-}concentration. According to Newton's First Law of Motion and the Second Law of Thermodynamics, these ions tend to move in a straight line away from the "refuge" of the solid form. This is especially noticeable when we surround the microcosm of calcium carbonate with large quantities of relatively pure water. If the added water contains Ca^{2+} or CO_3^{2-}ions, however, the divergence of the Ca^{2+} and CO_3^{2-}ions from the refuge is hampered—collisions between Ca^{2+} and CO_3^{2-}ions tend to increase and calcium carbonate forms again. Our conclusion: the fate of calcium carbonate is determined as much by the macrocosm in which it is found as by its individual components.

Biological and chemical "refugia" have many important similarities. Both have a noteworthy tale to tell about the same fundamental reality. We expect both organisms and chemical combinations to be clustered or ordered in some fashion. We also expect that there will be some comparatively independent individuals hovering around the main body. No matter how much the group grows or declines, there always will be these individuals who only fit in peripherally and occasionally but who nevertheless play the major part in the evolution of the microcosm. If the macrocosm changes in a certain way, many of these individuals will be forced to join the group. If it changes in another way, they may be forced out of the group. Similarly, individuals in the group may change (mutation is one example) and the group as a whole may develop in ways that allow for expansion into the macrocosm in spite of the previously inhospitable conditions there.

Biological and chemical "refugia" have many important dissimilarities. These include the obvious ones, such as size, shape, and special abilities that arise only in one and not the other. At the moment, most biological combinations seem too complex to be described by simple mathematical constants, whereas most chemical combinations can be described by constants used to predict the relative concentrations of uncombined molecules or atoms in solution. Biological species appear to be propelled independently of macrocosmically derived inertia, whereas chemical species have no visible means of propulsion other than inertia. It is only the *general* form of the analogy between the biological and the chemical that has a useful application in explanation and prediction.

Nevertheless, the physical phenomena that occasioned the concept of the refugium and the Law of Mass Action dispel idealistic notions about groups, whether they are groups of organisms or groups of molecules. An obvious lesson is applicable to all groups: if we wish a group to grow, either the microcosm or the macrocosm must be changed in a certain way. To increase the size of the refugium, the conditions within the macrocosm must be changed to be more like those within the refugium. To grow large calcium carbonate crystals, one can slowly evaporate the water in which the calcium and carbonate ions are dissolved, thus reducing the possibility of the ions diverging from the solid phase. The size of the microcosm of the group is dependent on the univironment: the microcosm and the macrocosm acting in consort. Only neovitalists and utopians believe that a group can expand or contract independent of conditions in the macrocosm.

The whole history of the earth's plant distribution is the history of refugia.[417] The idea is so powerful that indeterminists have thought it necessary to issue warnings that it does not explain everything.[418] Both the concept of the refugium and the Law of Mass Action are special cases of the Theory of the Univironment.

Population Growth and Chemical Reaction

Another analogy between biology and physical chemistry involves population growth. One of the first experiments the student performs in elementary chemistry is the titration of an acid with a base (Fig. 10-1). Small amounts of a base, such as NaOH, sodium hydroxide, are added at intervals to a strong acid, such as HCl, hydrochloric acid. The OH^- of the hydroxide combines with the H^+ of the acid to form water, H_2O:

$$H^+ + OH^- \leftrightarrow H_2O \quad (10\text{-}2)$$

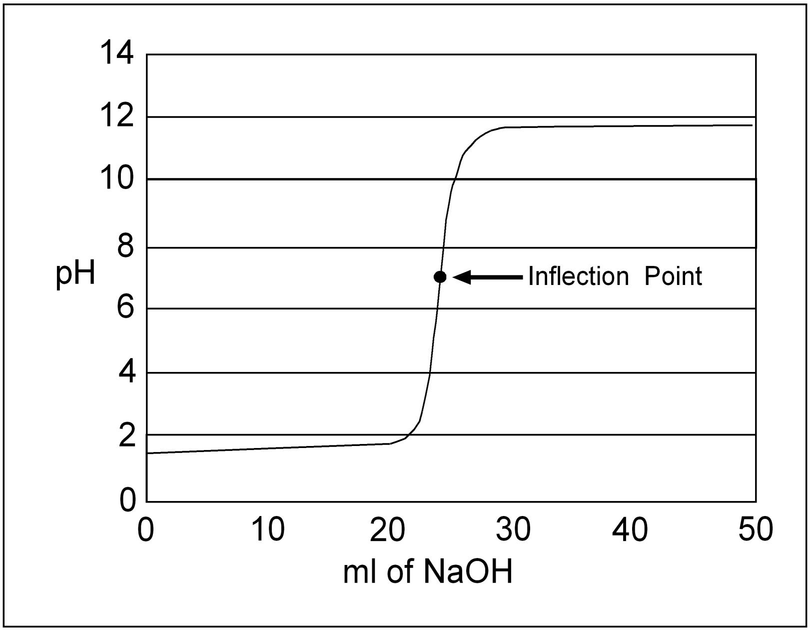


Fig. 10-1. Acid-base titration curve for the titration of a strong acid with a strong base.

Measuring the remaining acidity monitors the progress of the reaction. When the first OH^- is added, it immediately collides with one of the numerous H^+ ions in the solution. Of course, the formation of water as a result of the collision effectively removes one H^+ from the solution and the acidity decreases. That is, the pH (the negative logarithm of the hydrogen ion concentration) increases. The increase is exponential, that is, until it reaches what to chemists, biologists, and sociologists is a state of momentous importance: the *inflection point*, the point at which the change in the rate of change goes from positive to negative. This is also the point at which the number of OH^- ions in the solution is equivalent to the number of H^+ ions. Additions of OH^- result in increases in pH, but at an ever-decreasing rate. After a while, large increases in OH^- produce insignificant increases in pH. According to the Law of Mass Action, there are always some H^+ ions in solution, but at high pH there are so few of them that collisions with OH^- are infrequent.

The population growth of all biological species tends to produce sigmoidal (S-shaped) growth forms analogous to the simple acid-base titration (Fig. 10-2). In both chemical and biological microcosms, the formation of a product inhibits the formation of more product in accord with the major theme of Univironmental Determinism: the microcosm changes the macrocosm and the macrocosm changes the microcosm. In both cases, growth is density and activity conditioned. Also like the Law of Mass Action, the law of sigmoidal growth can take as many forms as there are microcosms to be described, but there is a basic S-shaped structure on which variations are superimposed.[419] Some of these curves are truncations of the basic S-shaped curve and actually end up being J-shaped due to drastic changes in the macrocosm. Still others involve so many different univironmental relationships that the basic sigmoidal structure is nearly unrecognizable. The primary form, however, teaches a valuable lesson.

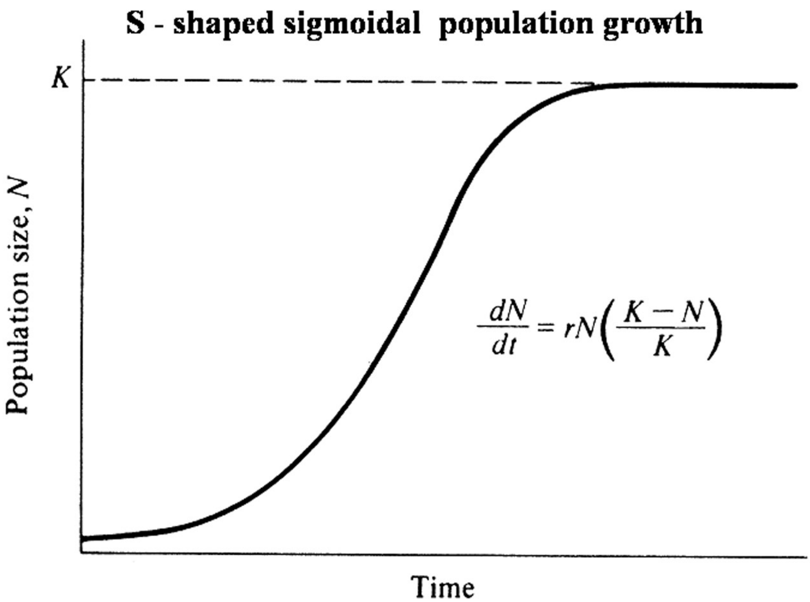


Fig. 10-2. Ideal sigmoidal population growth of organisms. The biological microcosm expands exponentially until it collides with the macrocosm, which exerts ever-increasing control.

The ideal sigmoidal curve involves submicrocosms that change the macrocosm in such a way that a particular change immediately influences the development of the next submicrocosm. Certain organisms, for example, secrete toxins that are effective against the growth of their own kind. Reproductive material survives only in areas without the toxin. As the number of new toxin-secreting organisms fills a particular area, fewer and fewer nontoxic areas are left in which new organisms can develop. Such a community reaches univironmental equilibrium when the only additions to the population come as a result of the deaths of others. In this way the microcosm of the population achieves univironmental equilibrium, which, like all forms of birth control, is clearly influenced by the macrocosm as well as the microcosm.

This idea is also embodied in the ecologist's concept of the climax community.[420] *Climax communities* are those ecological communities in which, in relation to their environments, there is little growth or expansion occurring. Of course, like all equilibria, climax communities are subject to convergent and divergent motions that assure future change. Changes within the univironment eventually lead to the transformation or extinction of the climax community.

The Complexity-Stability Muddle

The examples above had one thing in common: they were clearly univironmental. It was easy to eschew a systems-type analysis and stress univironmental analysis by considering the phenomena represented by one side of a reaction as a microcosm and the phenomena represented by the other side as a macrocosm (and vice versa). The major point: equilibrium in chemistry and the "balance of nature" in biology are fundamentally the same phenomenon.

The universe consists of two parts: microcosm and macrocosm, and unless we analyze one with respect to the other, we learn nothing about either. Even systems analysts cannot avoid concessions to univironmental analysis. They must divide their so-called isolated system into at least two subsystems to study it at all. When the division is done properly, the results obtained from the two methods will be indistinguishable. The rub comes in the application of those results. The most common mistake occurs when the systems analyst regards the properties of subsystems and their interactions as properties of the system as a whole. The analyst tends to forget that anything that could be called a system property actually must involve a relationship between the system and its surroundings.

I have alluded to this problem before, particularly in the chapter on *complementarity*. Now, in ecology there is an especially interesting paradox that only can be resolved by the firm application of univironmental analysis. It seems that ecologists have divided into two warring camps over the question:

Does increased complexity produce ecological stability?

The majority opinion seems to be "yes," the more complicated a biological community, the more stable it is. Advocates of this position often compare the complexity and stability of plant communities in the tropics with the simplicity and instability of plant communities in the arctic. The contrary opinion has been argued by ecologist Robert May, who claims that "the more the species in a single trophic level model, the less the stability."[421] May says "too rich a web connectance or too large an average interaction strength leads to instability."[422] He claims that even the math supports his side of the argument: "There is no comfortable theorem assuring that increasing diversity and complexity beget enhanced community stability; rather, as a mathematical generality, the opposite is true."[423] The whole debate, of course, is simply a logical muddle and serves only to illustrate another of the failings of systems philosophy. Both sides assume that stability is a system property when it is a univironmental relationship instead. The question itself is meaningless.

In the deterministic view, all ecological systems, like all microcosms, move toward univironmental equilibrium (stability). Sometimes this results in complexity; sometimes it results in simplicity. It is worth repeating again: stability, like other measures of motion, is never a property of the microcosm, but a relationship between the microcosm and the macrocosm. Systems philosophy, by definition, cannot absorb this fact.

Like the other controversies fundamentally centered on the relative importance of microcosm or macrocosm, all that the complexity-stability muddle can offer the scientific world is comic relief. Throughout history the primary political question has been: do univironmental conditions now require a more complex social organization than we currently have or a simpler one? In typical fashion, Robert May's studied defense of the complexity-means-instability side of the muddle ended up revealing nothing more than his veiled political bias: "predator-prey bonds in the food web tend to have a stabilizing influence, symbiosis or mutualism tends to be destabilizing."[424]

The Univironmental Reality

In summary, the biological microcosm, having been a response to primitive univironmental conditions, now responds to advanced univironmental conditions. Despite indeterministic objections, we find that the physicochemical model and the biological model have certain fundamental similarities that can help us understand, in a general way, why biological microcosms behave as they do. Thus, both the concept of the refugium in biology and the Law of Mass Action in physical chemistry reflect a similar underlying reality.

Chapter 11

The Human Microcosm

Man is a microcosm.[425]

No matter how much we humans glorify ourselves, we remain, like all other portions of the universe, *microcosms*. And like all other microcosms, our activities are produced univironmentally: by all that matter in motion inside us and all that matter in motion outside us. We come to this perception with the greatest reluctance because, in addition to philosophical conflict, it invariably brings a challenge to our own estimate of our place in the universe. For some people this requires a rejection of a solipsistic feeling of superiority over nature; for others it means a rejection of a fatalistic feeling of inferiority under nature. New comprehension requires an exchange of reality for romance.

Classical mechanism was the first scientific worldview to force this issue. The indeterministic response was the Cartesian accord. In the twentieth century the downfall of finite causality and classical mechanics led to the rise of systems philosophy and the restoration of apparent autonomy to the biological microcosm. It was no longer necessary to claim that animals were mere biological machines and that humans were machines plus, because hardly anyone ventured either claim anymore. Instead, the modern paradigm tended to view both the animal and the human as "systems": entities relatively isolated from their environments. The infinite complexity that went unacknowledged in classical mechanics was given the name "chance" and was bestowed on the system itself. As we will see, this only amounted to new dress for an ancient error.

Both mechanism and the Cartesian compromise have served their historical purpose. We need not treat animals—or people—as though they were Newtonian objects—things with nothing inside them except pure, finite, inert matter. We need not treat animals—or people—as though they were systems—things with nothing outside them except an immaterial void.

Systems philosophy eventually will go the way of classical mechanism, and with it will go our anthropocentric practice of attributing to the system that which the system and the environment achieve together. We no longer need consider ourselves isolated from the macrocosm, foolishly grasping for a nonexistent, unprecedented freedom. We can discard the microcosmic bias currently sanctioned in the social sciences and we can look at ourselves in a univironmental way. In this chapter I try to promote that perspective in a discussion of a few of the important characteristics and behaviors that make the human microcosm unique.

The goal of science, of all human knowledge, is to make accurate predictions of events that concern humans. As population densities increase and worldwide interrelationships intensify, more and more of our personal environment involves other human beings and their artifacts rather than other natural microcosms. Other humans can be dangerous as well as fun, hating as well as loving. To survive mentally, as well as physically, we must be able to predict human behavior. The more accurate those predictions, the easier it is for us to get along with each other.

"Unpredictable" people are difficult to live with. They become predictable to us only after we have studied them for some time. Each of us makes fairly accurate predictions about people every day. For instance, as automobile drivers we predict that the traffic in the oncoming lane usually will not veer from that lane. We predict that, when the stoplight is green, we may proceed without interference. We predict that we can control other people by displaying the proper signals. The ability to predict and to control what others will do is absolutely necessary for our existence.

We attain this ability in two ways: by accepting the advice of those more experienced than ourselves, and by personal experiment—that is, by active involvement with other people. If we are honest and educated we admit that we try to influence others to serve what we judge are our best interests. If we are dishonest or ignorant we may disavow our motives even as our actions continue to influence others. We all want to change the world, and because so much of the world includes other people, we had best admit that we want to change people too.

Toward what ends should we change each other? The cynics already know. The manipulators, the advertisers, the brainwashers, are all about us. They consciously plan campaigns to alter or to fix our views even though the results often are not in our own best interests. In spite of such questionable overtures, we need to discover for ourselves what portions of our culture to preserve and what portions to change to prolong our all-too-temporary existence. To do so, we have no alternative except to expand our personal knowledge of human behavior, and because most of us have little time to devote to that effort in a formal way, it is imperative that we view it from the most efficient perspective.

Needs: Key to Human Behavior

The univironmental approach to understanding human behavior views each act, each motion, of the human microcosm as a means to satisfy some human need. Having discovered what the needs are, one can attempt to predict what actions are likely to be taken.

There is not only much complexity, but also much confusion on the nature of human needs. For instance, it is quite common to hear otherwise educated people make silly claims like this: "Technology can be stopped by stressing human needs."[426] Technology, however, is nothing if not a response to human needs, however perverted they may seem. The fact that a particular technological innovation addresses the needs of only a minority and is even antagonistic to those of the majority would be surprising only to an idealist. A definition of needs is in order.

Definition of Needs

As I define them, *needs* are particular univironments resulting in particular kinds of behavior. The practical value of this rather inclusive definition lies merely in its ability to focus our thoughts properly. It stresses that neither needs nor behavior are properties of the microcosm alone. Because all reactions are toward "univironmental equilibrium," the least amount of motion for the conditions, all behavior must be seen as liberal action toward a conservative end. The human microcosm changes the macrocosm so that it may undergo the least amount of change possible, so that it may exist in a state closest to what it was before the change became necessary.

Needs imply imminent behavior, the result of which is the disappearance of the need (the alteration of the univironment) along with disappearance of the behavior. In its most simplistic form, this way of analyzing needs gives us a ready answer to all questions concerning behavior: "they do that because it is the only way for them to move toward univironmental equilibrium." This admission is the most powerful first step one can take toward understanding behavior. It tenaciously refuses to adopt the indeterministic view that the causes of behavior stem from the microcosm or from the macrocosm working independently of one another.

Needs arise through inevitable changes in univironmental relationships. As we are well aware, human behavior, like the other forms of motion, is infinitely varied. Nonetheless, human beings can be studied with the same methods that have been used successfully on other parts of the universe. We can simplify by delineating, as a microcosm, a single human being, or we can complexify by delineating, as a microcosm, more than one human for study. We can enlarge the microcosm to consider the behavior of groups of people (social microcosms) to which the concept of need still applies. The most important point through all of this is to maintain sight of what it is that we study: the main features of the microcosm in relation to the main features of the macrocosm.

A short example illustrates how univironmental analysis can help us understand behavior.

Example: Huck and the Apple

It is a warm, sunny day in the country. Huckleberry Finn, the otherwise adventurous lad for whom such lazy days seem to have been made, is off in the distance relaxing beneath an apple tree. Outwardly, his behavior appears minimal; it seems little more than breathing. After a while, he stands up, reaches into the tree, gets an apple, eats it, and resumes sitting. What have we observed? How does the concept of needs as univironments resulting in behavior help us to analyze and predict behavior in this instance?

First of all, we must consider Huck as a microcosm. We really don't know exactly what his needs are, but then again, he is "only human"—he probably likes apples. The macrocosm here, too, is unique. It contains an apple tree and not, for example, a lemon tree. The univironment we are focusing on today is similar to and yet different from those we have encountered in the past. Of course, we cannot have definite knowledge of a person's needs until they have been met. Still, we can "guess" or make a prediction that, like all predictions, will be no better than the information on which it is based. To predict behavior, we must gather as much applicable information as possible, and we know from where to gather it. We will ignore neither the microcosm nor the macrocosm.

In general, the behaviors that satisfy needs are similar to the simplest of chemical reactions. Let me digress a bit to draw a univironmental lesson from another of those lowly chemical analogies. It is a fact that the microcosm of a calcium ion will "behave" differently depending on the macrocosm in which it exists. In the presence of a carbonate ion it forms insoluble calcium carbonate. In the presence of a chloride ion it forms soluble calcium chloride. If the microcosm of the calcium ion had within it only enough neutrons, protons, and electrons to form a sodium ion, then both the carbonate and the chloride would be soluble. Both the microcosm and the macrocosm must be of special types for calcium carbonate to form.

Obviously, unless the microcosm of calcium converges on the macrocosm of carbonate, a combination of the two is out of the question. They converge through simple inertia; that is, each ion moves relative to other portions of the universe as a result of collisions with still other portions. The so-called "need" of the microcosm is met only through a complementary "need" of the macrocosm. A certain kind of motion of matter in the macrocosm produces a certain kind of motion of matter in the microcosm. New needs are produced when the "main features" of the univironment change, thus producing a new set of conditions leading to still other changes in the univironment.

The behavior of Huck Finn is different only in that millions of such reactions must interact to accomplish it. Imagine the complexity required just to eat an apple! Each tiny submicrocosm within the microcosm of Huck's body moves toward univironmental equilibrium. Matter within the stomach, eyes, brain, and other organs moves toward univironmental equilibrium. As time passes Huck grows hungrier and more restless; the apple becomes riper and more enticing. Deep within Huck's brain is encoded a chemical sequence that, in interaction with other sequences stimulated by Huck's sensing the apple, will provide finally the decision that activates the rest of his body. This single decision is an effect that continues a causal chain of reactions that call forth millions more. An arm, a leg, a body moves. Huck converges on and eats the apple—his needs are met. When the act is completed, his outward signs of behavior cease; univironmental equilibrium is temporarily achieved once again.

As we know, satisfaction is never guaranteed. When and if it is achieved, satisfaction is only temporary. The submicrocosms and the supermicrocosms within the univironment are continually in motion relative to each other; old univironments produce new univironments. New needs arise as old ones are fulfilled. Huck Finn would not have "needed" the apple in the first place if apples had never existed or if he believed that they were inedible. Historically, apples became a need only after it was found that they could substitute for other ways of satiating hunger and giving pleasure. Needs evolved as univironments evolved.

In our rapidly developing society we are confronted daily with needs that do not exist for us until others bring them to our attention. The struggle between producers and consumers is unceasing. The need for producers to sell confronts the consumers' reluctance to work for objects or services that substitute for ones that already satisfy their needs after a fashion.

The macrocosm in which the human microcosm now exists is so very different from that of just a century ago, and so the needs are different. Nowadays more and more people need automobiles, not horses; social services, not religious services. While it is true that the elementary needs of the human microcosm could be met in a fashion more primitive than that which now exists, the macrocosm is becoming less and less capable of meeting them in that way. It is no longer possible for each of us to have the luxuries of a log cabin, forty acres, and a mule; we will have to accept autos, televisions, and home computers instead.

Systems philosophers, by definition, cannot accept the view of needs outlined here. Needs typically are seen by them as internally derived, inborn, instinctive, and, above all, static. Viewed as hermetically sealed from the rest of the universe, the god-given needs of the indeterminists never change. They are handed down from generation to generation, perhaps genetically, as the sociobiologists claim. Any human behavior obviously not linked to what indeterminists regard as a legitimate need is considered irrational and uncaused. The blame for antisocial behavior tends to be laid entirely on the individual, and the corrupt societal context in which it occurs tends to be ignored.

In regard to the concept of needs, the naïve realist and the systems philosopher are liable to share this microcosmic preoccupation. The response of the human microcosm to changes in its macrocosm is so often delayed and transformed in infinitely varied ways. As long as they cannot easily detect the connections, both the casual observer and the systems philosopher are apt to think they have found system properties when they have really found univironmental interactions instead. To understand needs we must consider univironments dynamically. Thus the answers must be looked for in temporal relationships—that is, through an evaluation of the historical evolution of the univironment of concern. This is seldom easy, as seen in the next section.

The Heredity-Environment Muddle

By defining needs as univironments—that is, relations between the microcosm and the macrocosm rather than as properties of either one—we are led to a revision of other views concerning human behavior. In the rest of this chapter I attempt to show, in a general way, how the univironmental approach can shed new light on issues obscured by indeterminists. One such issue is the classical debate concerning the relative importance of heredity and environment in determining behavior. Also known as the nature-nurture debate, the heredity-environment muddle is one of the favorite topics of social scientists guided strictly by systems philosophy.

One famous cycle in the hostilities occurred in the '70s with the publication of entomologist E. O. Wilson's book *Sociobiology: The New Synthesis*.[427] Arrayed on one side of the muddle were the *hereditarians*, such as Arthur Jensen[428] and William Shockley,[429] who believed along with Wilson that heredity is far more important than environment in determining human behavior. On the other side were the *environmentalists*, such as Michael Ruse,[430] who believed that the environment is far more important than heredity in determining human behavior. More than most scientific controversies, this one easily shows its political character. A look at the muddle is interesting for the politics if not for the science.

Hereditarianism and the Right

The conservative view can be traced at least as far back as social Darwinist Herbert Spencer in the nineteenth century. In support of the prevailing thought of the day, Spencer claimed that it was "unnatural" to try to eradicate poverty because this would interfere with the survival of the fittest. In our time, Shockley used a variant of that argument to question the value of publicly funded environmental changes designed to help those he deemed "genetically inferior."

Although modern hereditarians such as Wilson occasionally admit that "mankind has never stopped evolving,"[431] a close look at their work shows that, invariably, they do not see this evolution in an all-inclusive, univironmental sense. Spencer, the proto-Darwinist, failed to see the attempt to eradicate poverty as part of the evolutionary process. Wilson, the neo-Darwinist, repeated the same mistake, merely stating the gospel in a more sophisticated manner. As mentioned before, evolution is still viewed by neo-Darwinians, imbued with systems philosophy, as a sometime occurrence. Thus we should not have been surprised when Wilson found it unfortunate that our "populations are drifting,"[432] implying that, with a hereditarian at the helm, our ship could be guided back to its proper "natural" course.

To get an idea of what this new salvation might be like, one only needs to examine the "scientific" work used to legitimize the hereditarian point of view. Typically, whenever different races are compared, the investigator's own race does best of all. A classic case is that of Samuel Morton, a Philadelphia physician who, in the early nineteenth century, amassed a collection of over 1,000 human skulls, measured cranial capacities, and ranked the races accordingly.[433] Morton concluded that the cranial capacities and innate intellectual abilities of whites were greater than those of American Indians, and that these were, in turn, greater than those of blacks. The results agreed with the expectations of the day and were avidly disseminated in textbooks throughout the United States. Stephen Jay Gould's statistical evaluation of the raw data, however, failed to confirm Morton's interpretations. The discrepancies appear to be, as Gould so generously put it, a result of "unconscious or dimly perceived finagling."

Morton was so kind as to leave us with the original, carefully made measurements. Others, such as Sir Cyril Burt, the first psychologist to be knighted and once the mentor for a large crop of hereditarians,[434] not only fabricated data, but also invented coworkers to help promulgate the "results."[435] Burt's widely acclaimed 1961 study correlating intelligence and social class presented data that was statistically too good to be true. Microcosmic bias of this sort might be of little concern if it could be confined to academia, but it is potentially serious for the rest of us.

Racists, by anyone's definition, are to be found on the hereditarian, microcosmic, side of the argument. Purported scientific justification for deeply ingrained racial prejudice generally finds a receptive audience among bigots. The hereditarian logic becomes increasingly popular when individuals and nations first come under stress and begin a search for scapegoats. The decline of the British Empire brought the eugenics movement; the military and economic defeat of Germany in World War I brought the genocide of World War II. As long as there are racists, the system-oriented side of the heredity-environment muddle will be more than adequately represented. The hereditarian argument has become increasing sophisticated, with "compassionate conservatism" now tempering the conclusions.[436]

Environmentalism and the Left

If one was neither a racist nor a reactionary, but still disposed to join the muddle, it would have to be on the side of the environmentalists. The most celebrated case involved Trofim Lysenko, an intellectually mediocre official in the USSR during the Stalin years.[437] Lysenko believed in a simplistic form of Lamarckism—the direct inheritance of acquired characteristics. In his view, the science of genetics was unnecessary. His rise to power was accompanied by a McCarthy-like purge in which careers were destroyed and recalcitrant scientists were imprisoned and even executed. The study of genetics was all but abolished in the Soviet Union as a result of his tactics.

Meanwhile, genetics in the United States flourished, producing great advances in medicine and agriculture. Nevertheless, the outrageous claims of its peculiarly American side effect, sociobiology, did not go completely unanswered. Just as soon as sociobiology burst forth, leftwing idealists saw the racist implications and reacted by "bending the stick" in the other direction. As the debate heated up, one prominent biologist was even quoted or misquoted in the press as saying that "Nothing we can know about the genetics of human behavior can have any implications for human society."[438] Tempers flared, parties to the debate were picketed, and Wilson himself was doused with a glass of water at a symposium of the American Association for the Advancement of Science.[439] The debate at least stimulated a raft of books in opposition to the hereditarian viewpoint.[440]

Unfortunately, much of the new left reaction to the hereditarian threat had a distinctly indeterministic flavor. In accepting sociobiology's so-called "biological determinism" as truly representative of determinism, leftists were forced to dredge up tired arguments against reduction per se and in favor of free will and the development of culture independent of evolution.

Fortunately, sociobiology has participated very little in the recent popular movement of the right in the United States. Partly, this may be because many of the arguments of the sociobiologists are quite complicated and probably are a bit much for that crowd. Even so, it is questionable whether environmentalists will be any more successful in combating the hereditarians than the last time they got loose.

Univironmental Determinism

From the scientific point of view, neither the hereditarian nor the environmentalist can be correct. It is a false dichotomy.[441] The hereditarian overemphasizes the microcosm; the environmentalist overemphasizes the macrocosm. The behavior of the human microcosm is determined by both the microcosm and the macrocosm. When the microcosm and the macrocosm are seen as a univironment, the heredity-environment muddle vanishes as a concern for serious debate. No longer is it theoretically meaningful to ask, how much does heredity contribute? How much does environment contribute? The absurdity of those questions was demonstrated after a letter from sociobiologist Darius Baer[442] slipped through the editorial auspices of *Science*. Baer claimed that the "underlying concept of sociobiology and behavioral genetics" was embodied in the equation:

$$P = G + E + GE \qquad (11\text{-}1)$$

Where:

P = measured value for some character of an individual

G = value conferred on the individual by its genotype

E = environmental deviation resulting from all nongenetic causes

GE = deviation resulting from genotype-environment interactions or the differential response of different genotypes to different environments

The damage was repaired in a subsequent issue of the journal and it didn't take an environmentalist to do it. Shortly after I submitted a letter to *Science* voicing my objection with regard to equation 11-1, the journal printed a nearly identical letter by the noted sociobiologist D. P. Barash who gently pointed out that "Baer's statement is more accurately recast: P = GE."[443] Even Barash could see that no organism exists in the absence of an environment. Most sociobiologists would dearly love to isolate genetic and environmental factors as implied in equation 11-1, but it can't be done. In his mathematical travesty, Baer imagined that a phenotype would exist even though either the genotype (G = 0) or the environment (E = 0) did not. He only succeeded in proving, once again, that the mathematization of nonsense is still nonsense. Asking which contributes most to the heredity-environment interaction is like asking which contributes most to the area of a rectangle: its width? Or its length?

Noticeably missing from the sociobiology debate were those who much earlier pointed out that the whole thing was simply moot. More than a decade earlier, even the ultraconservative biologist Garrett Hardin maintained that, "As a matter of method, we should not ask, 'Which is the cause—heredity or environment?' but rather, 'How do heredity and environment act together to produce the effect observed?'"[444] If the heredity-environment muddle is so much a transgression of scientific method, as it certainly is, then why is it still being presented as if it were legitimate science? When will biology and sociology put their house in order?

As I pointed out in the discussion of microcosmic and macrocosmic mistakes, it is easy for specialists to lose sight of the univironmental picture. In the examples below I use univironmental analysis in an effort to restore some balance to the way we look at heredity-environment interactions.

Example: PKU

One of the most familiar heredity-environment interactions concerns phenylketonuria (PKU), a genetic disposition in which the body is unable to convert one of the amino acids, phenylalanine, to tyrosine. It is instead converted to a ketone, phenylpyruvic acid, which affects brain development, producing mental retardation. Fortunately, by means of a standard test now given to most newborns, PKU can be detected, a special low phenylalanine diet can be prepared, and the retardation can be prevented. Two extremely different outcomes can result depending on the nature of the macrocosm. In this case, the macrocosm has evolved to compensate for what is viewed as a deficiency within the microcosm.

Although hereditarians may view PKU and other genetic predispositions as evolutionary, they tend not to view its cure as evolutionary. J. E. Cawte,[445] for instance, was typical of those who believed that the treatment of genetic disorders was inadvisable. For Cawte, whatever the genes did was naturally good and progressive and whatever people did to interfere was bad and regressive. Cawte believed as Herbert Spencer: the microcosm evolves but the macrocosm does not.

Example: Intelligence

Strictly speaking, intelligence is a univironment, a relation between the microcosm and the macrocosm. Like stability and equilibrium, intelligence cannot be a property of the microcosm. When we say that certain people are intelligent or stable, we must have in mind their dealings with a particular environment. Just as no one can remain "stable" under certain types of provocation, so no one can be "intelligent" in all environments. Einstein, for instance, was less than a genius when he found himself in unfamiliar environments. A chemist may be a "genius" in chemistry and a "moron" in history; an historian may be a "genius" in history and a "moron" in chemistry.

So-called "native intelligence" is a myth. People are not born knowing vocabularies and multiplication tables. At most, people are born with central nervous systems that vary in the speed and capacity with which they store, retrieve, and process information. Much of what we lack in speed we can make up through hard work. Thus the formula for memorizing a page of text is:

$$M = RT \quad (11\text{-}2)$$

Where:

R = Rate of memorization, words/minute
T = Time, minutes

It may take me ten times longer than another person to memorize a script, but a recitation will prove us both "geniuses." The recitation reveals little about my ability to learn but much about my having learned.

Hereditarians insist nonetheless that intelligence is something intrinsic to the microcosm itself. Like the indeterminists who searched for the "vital element" in the cell, hereditarians now search for intelligence in the gene. Heavy theoretical concentration on the gene seems to make one forget that genes are only a small part of the human microcosm and that the environment of the gene and environment of the human are two different things.

The result can be not only a severe case of mixed microcosms, but also an absurd reduction such as that portrayed by Richard Dawkins in his book aptly titled *The Selfish Gene*.[446] The gist of this vulgarity was the proclamation that we are "gene machines," existing at the behest of our DNA. In Dawkins's view, the natural situation is pretty grim because these genes don't have an altruistic bone in their bodies. The only ground for optimism exists, according to Dawkins, in the possibility of a renewed fight against matter. "We, alone on earth can rebel against the tyranny of the selfish replicators." Let's all hope we win!

Intelligence must not be viewed apart from its context. IQ is what IQ tests measure, a relationship between a particular microcosm and a particular macrocosm at a particular moment. Any test measures the response of a microcosm to changes in the macrocosm. Thus if we get a "correct" answer to a question, we may consider a person intelligent; if we get a "wrong" answer we may consider a person ignorant. Any response is a univironmental response. Just as the answer "yes" is meaningless without a question, a test score is meaningless without some knowledge, not only of the test, but also of the people who devised it and the person who responded to it. The question itself may be stupid.

High test scores tend to reflect a high degree of cultural and intellectual similarity between the tester and the test taker. We naturally have a tendency to judge the appropriateness of another's actions by what we deem would have been the appropriateness of our own. For example, one's dashing into the path of a speeding auto normally would be seen as a less than intelligent act because it could result in bodily harm. In most cases, actions that result in the continued existence of the actors, their associates, or their ideas are seen as appropriate and intelligent, whereas those that do not are suspect.

Thus, to get along in society, our responses to the questions posed by society must be appropriate. To give an answer that is deemed inappropriate by those in a judgmental position is to risk a label of "ignorant" or, even worse, "irrational." Every test has its consequences and people intuitively and wisely sense the element of threat that is involved. Testing is never a neutral process. Wise respondents contemplate the motives of those who write and administer tests.

If we consider the knowledge in our brains and contemplate how it got there, we must admit that much of it was not of our own doing. If not for hereditarian propaganda, it would be obvious to all that without macrocosmic influences we would not have intelligence at all. If rewards are to be given for intelligence, shouldn't they be shared with understanding parents, exciting teachers, and the authors of the books that changed our lives? Intelligence is a community project. If we spend our lives in a community that fosters intelligence, we become intelligent; if we spend our lives in a community that harbors ignorance, we remain ignorant.

Humans are fascinating for their obvious infinite variety and complexity. Compared to that of other microcosms, the predictability of human behavior generally is regarded as low. This is all the more reason to view it from the univironmental perspective. In this regard the failures of systems philosophy are notable: treat antisocial individuals poorly and then send them back to environments sure to contribute to a relapse. Until we learn to treat the macrocosm as well as the microcosm, our efforts to help individuals who have behavioral problems will be largely wasted. The social disaster produced by the current approach continues to escalate while the opportunity to apply a balanced view has never been greater. For example, we spend billions on prisoner "rehabilitation," while nearly ignoring the conditions that virtually force young people into a life of crime.

The switch from systems philosophy to Univironmental Determinism also allows us a fresh look at what have been regarded by some as unsolvable problems concerning human existence. While there is no complete, unmodifiable answer to any question, even the toughest can be within range if approached with the proper assumptions. We should not be surprised that paradox disappears when we give up incorrect premises. Our evaluation of consciousness and of ethics in the next two sections is crucial to an understanding of our place in the universe.

Consciousness

The human microcosm is ordinarily considered unique because its behavior cannot be described without using the concept of consciousness. The vast complexity of the human brain and nervous system allows lengthy delays in response to macrocosmic impacts. The billions of photons, atoms, organic molecules, inorganic molecules, and other things in the macrocosm collide with and transmit motion to our sensory organs, which, in turn, stimulate the motions of electrons and other submicrocosms in the central nervous system. Characteristically, indeterminists claim it is "impossible for us to comprehend how material being can give rise to the enigmatic appearance of consciousness. Accordingly the demand for "explanation" not only cannot be fulfilled here—strictly speaking it cannot even be raised. Ignorabimus is the only answer that science can give to the question of the essence and origin of consciousness."[447]

The mystery can be intensified by stressing the dissimilarities between animals and humans, thereby cutting the evolution of consciousness from its origins. After stressing the complexity and the unexplained and ignoring the evolutionary continuity of the relation of consciousness, indeterminists are free to invoke the supernatural to "explain" that which, by their own rules, cannot be explained.

Even a cursory familiarity with other species of animals, however, must grant to them at least a rudimentary intelligence and a primitive consciousness. ***Disconnection*** ultimately succumbs to the test of experience. As the French materialist Baron D'Holbach said almost two centuries ago, "It is the height of folly to deny intellectual capacities to animals; they feel, think, judge and compare; they choose and deliberate, they have memories, they evince love and hatred, and their senses are often more delicate than our own."[448]

Have we learned nothing since? Is the evolution of consciousness all that unexpected? Does consciousness really have all the powers that indeterminists customarily attribute to it? Our modern, sophisticated indeterminist is a systems philosopher who typically links the advent of consciousness with free will and neovitalism; "human consciousness emancipated man from the confines of his sensory reality and placed him within a world he himself created."[449]

A more careful, univironmental look at this emancipation, however, finds it to be none other than the ancient delusion of the solipsist, for whom consciousness is an inner world completely independent of macrocosmic reality. To avoid that predicament, we must first traverse the mind-brain muddle, another of those sticky philosophical obstacles confronting the searcher after truth.

The Mind-Brain Muddle

For ages philosophers and scientists have debated the "relationship" between the mind and the brain. Is the mind some kind of ghostly entity independent of the brain and the rest of the physical world? Are the mind and brain identical? Is the mind a special form of the motion of matter within the brain? These questions are powerful philosophical discriminators; a positive answer to any of them identifies a person with spiritualism, materialism, or mechanism, respectively. As I have maintained from the beginning, there can be little sensible communication between people whose views fall into disparate categories, because each proceeds from different assumptions. When such a discussion is attempted, the result is a muddle or "logical mess" as Hans Reichenbach called it.[450] Until the terms *mind* and *brain* are defined, the mind-brain question is meaningless.[451] When they are defined, the debate and the muddle disappear. Let us examine the three possible resolutions of the mind-brain muddle.

Spiritualism

Our ancestors lived in dread of spirits: "things" that could not be seen but nevertheless could affect their lives. The air could not be seen, but when it moved, it moved other things that could be seen. Logically, spirit was possessed by anything that moved, and since motion was an everyday occurrence, an understanding of spirit was necessary for survival. The essence of the concept was the apparent absence of a material carrier for the motion that was spirit. Spiritualism, of course, is the mainstay of most religions, which provide a vast reservoir of belief in the assumption of ***separability***. Today, remnants of the idea of spirit exist in modern physics—for instance, whenever energy is regarded mistakenly as motion without matter.

This tradition of conceiving of motion as a matterless "thing" often has led our greatest minds astray. Even Galileo once proposed that mind was a class of beings outside nature.[452] These beings could influence, but could not be influenced. Hegel recognized that minds were not parts of nature, because they were not found situated in space.[453] Minds thus could not be matter because they were not three-dimensional. Conceptually, both spirit and mind nonetheless continued to have a finite, three-dimensional quality to them. Whenever a spirit or a mind acted, it acted in a particular place. It was localized here and not there, and whenever one conceived of spirit in that way, one conceived of it three-dimensionally—as a thing that was not a thing. The materialists saw the absurdity in this and proposed a solution.

Materialism

Nonmechanical materialists proposed that mind and spirit *were* matter. Pierre Gassendi, before Newton, held that mind was a structure of material elements. More recently, the mind has been called an "organism within an organism."[454] And in formal philosophy, there has been serious controversy over the Mind/Brain Identity Theory, in which some materialists still claim that the mind *is* the brain.[455] There are some tempting arguments in favor of this view since no one has ever experienced a mind not associated with a brain. The idea is consistent with beliefs in modern physics that treat motion and matter as identical. Nevertheless, the concept of the mind and brain as being both the same thing has its own problems.

The notion that the mind is an entity can be dismissed easily, as noted by Joseph Margolis: "One need not, in admitting that Peter has a pain, be obliged to admit that there are such things as pains, that pains are actual entities of some sort."[456] We may not have seen minds without brains, but we have seen brains without minds. Neither spiritualism nor materialism is equal to the task of explaining the phenomenon of the mind.

Mechanism

As mentioned, mechanism proceeds from the Fourth Assumption of Science: *inseparability*, the proposition that there can be no motion without matter and no matter without motion. The spiritualists conceive of motion without matter, while certain materialists conceive of matter without motion. For one, the mind exists without the brain; for the other, the mind *is* the brain. Neither is correct, for in reality, say the mechanists, mind is the motion of matter within the brain. Over a century ago even the so-called "vulgar materialist" Ludwig Büchner knew that "the word "mind" is in reality nothing more than a collective word and a comprehensive expression for the whole of the activities of the brain."[457]

Mechanists have insisted correctly that:

> All that really exists is the material particles of the substance of the nervous system. When these particles enter on a certain kind of chemical activity, the effect is to suggest the existence of some new kind of elusive nonmaterial entity called mind … this entity has no more real existence than has fire. In each case we have to do exclusively with molecules undergoing disintegration or combination.[458]

The classical mechanists may have had their difficulties with causality, but at least a few of them got through the mind-brain muddle.

Although the mechanistic concept of the mind has potentially infinite complexity, it is fundamentally simple. Thinking is what the brain *does*, just as running is what the legs *do*. It is impossible to have thinking without brain, just as it is impossible to have running without legs. While it cannot be denied that the brain exists in a particular physicochemical state at any particular moment, our thoughts, our pains, our joys are really not "states" at all as claimed by some materialists.[459] Thoughts are not analogous to residences, but to travels. "Consciousness … is a process, not a stuff."[460]

Holding fast to the primary assumption of the mechanists, Lenin warned that "consciousness should not be counted as matter … [T]o say that thought is material is to make a false step."[461] But according to cybernetician P. P. Kirschenmann, most of Lenin's followers no longer conceive of thought as motion.[462] If so, it appears that a false step indeed has been taken. It bears repeating that no one ever gets a complete understanding of a thing or an event by categorizing it as "matter" or "motion," but clear thinking is unlikely to occur before such a step is made.

Ironically, mechanism is compatible with spiritualism in denying that mind is matter and with materialism in denying that mind occurs apart from matter. That is because mind is the motion of matter—electrons and other submicrocosms found only in the brains and central nervous systems of extremely sophisticated biological microcosms. Having circumvented the mind-brain muddle, we may now explore the nature of knowledge and knowing.

Knowledge and Knowing

For our own good, we are obliged to "learn why the world wags and what wags it."[463] Time and again we hear that "knowledge is power" and that "science is revolutionary." Information technology is all the rage, and the Internet threatens to demolish the media monopolies of the power elite. Reactionaries of the ruling class might agonize about "how little wisdom there is in those people who want everyone … to participate in knowledge,"[464] while liberals proclaim it immoral to prevent the dissemination of knowledge.[465] Knowledge, power, science, revolution, life, global competition, survival—the interconnections are profound, and yet we can spend a lifetime ignorant of the true nature of knowledge and knowing. It is worth knowing much more about knowing.

Ironically, this subject, *epistemology*, is seldom comprehensible. This is because, not only is epistemology complex, but it is also an integral part of the philosophical struggle—one's interpretation of the nature of knowing depends on the assumptions one holds about the world. For indeterminists, epistemology is another of those great philosophical muddles. Einstein, for one, confessed himself baffled by the subject, finding it incomprehensible that the world should be so comprehensible. In typical fashion, Timothy Ferris says of epistemology, "All the mysteries of science are but palace guards to that mystery."[466] I will cover epistemology in quite some detail, not only because it is extremely important, but also because its analysis provides an excellent illustration of how univironmental theory can be used to attack a complex subject.

Indeterminists have developed a surefire way to make a phenomenon mysterious: consider it unnatural. While determinists believe that *causality* is all-inclusive, that it governs all the behaviors of the human microcosm, indeterminists are not so sure. Typically, they believe that humans can freely choose to know or not to know, and that they can freely choose to do it one way, or another way. Thus according to Ernest Nagel, the noted "philosopher of science:"

> It is undoubtedly only a contingent historical fact that the enterprise known as "science" does aim at achieving the type of explanations prescribed by the principle (of causality); for it is logically possible that in their efforts at mastering their environments men might have aimed at something quite different. Accordingly, the goals men adopt in the pursuit of knowledge are logically arbitrary.[467]

Imagine that! It is only an historical accident that sentient beings should seek the causes of events! *Causality* is logically arbitrary all right, but only for the indeterminist. Good luck in trying to learn epistemology from this standpoint. Such sympathies are little more than disguised ***immaterialism***. As we saw early on, the belief that knowledge can be developed independent of the external world is a foremost characteristic of indeterminism. Don't be fooled. The flowery language and the subconscious agenda are merely tools for maintaining the muddle and thereby supporting indeterminism.

Among indeterminists it is an act of faith that knowledge and science are two different things. Despite his brilliant promotion of *inseparability*, Hegel's views were typical.[468] Convinced that science should not have sole claim to the title of knowledge, he claimed another kind of knowledge, philosophical knowledge, which was knowledge of the infinite. Scientists could know only the real world, and such knowledge was necessarily finite. There has been no shortage of those who claimed to have special knowledge of the unreal world. Psychotics lead the way in hearing voices from it daily.

Of course anyone who denies the possibility of "knowledge" of the infinite or of the acausal is seen by indeterminists as deficient. Indeterminists, equating the unknown with the nonphysical, are represented in physics by those who really believe there are such "things" as massless particles. In epistemology, modern indeterminists are still holding out for the oxymoronic possibility of attaining a "knowledge of nonmaterial things."[469] But science and knowledge unavoidably refer to the same underlying physical reality. To suggest that science and knowledge are identical is to suggest that the indeterministic program is wholly without merit—that nothing besides its physical nature and interactions can be learned about the world. In typical fashion, one indeterminist showed his disgust with this view: "This belief … taken as the *only* way to truth in all aspects of life … gives science proper more power than it is capable of possessing."[470]

The technique here is to divide and conquer. With a twist and a turn, science becomes "science proper"—that is, the formal scientific establishment. The creation of such an exclusive club would mean, of course, that we are *not* all scientists. In that case it would be foolish to equate science and knowledge because the scientific establishment surely could not be the only supplier.

Unfortunately, not a few scientists, thinking themselves members of the elite, have covertly agreed to this phony classification by denigrating knowledge obtained outside "science proper." About the worst statement to that effect came from one V. K. Ting, a participant in the pre-revolutionary philosophical struggle in China. "I believe that conclusions not arrived at by the scientific method do not constitute knowledge at all. Within the realm of knowledge, the scientific method is omnipotent."[471]

Here we are to believe that only a so-called "scientific" model and not, for example, an artistic model, represents true knowledge. Neither determinist nor indeterminist is likely to tolerate such arrogant nonsense.

At times a distinction between scientific method and nonscientific method may be legitimate, but it does not follow that the results will be knowledge and non-knowledge. Ting used an old indeterministic trick, the argument that what *he* knows is absolute and what *they* know is fallible. The truth of course is that all knowledge is incomplete, fallible, uncertain, and subject to change. To understand the nature of knowing, we cannot exclude any of the activities of the knowing being. If knowledge is the result of the interaction of real humans with the real world, then whether we classify it as "science" or "religion," or as "determinism" or "indeterminism," makes no difference—it is still knowledge. Anyone who starts from Ting's point of view also cannot discover the nature of knowing.

No matter what anyone claims to the contrary, all knowledge, whether obtained by the methods of science or of religion or whatever else, starts with sensory experience. Scientists' heads are filled with images of test tubes, beakers, bottles, and instruments from their working environments. Priests' heads are filled with images of gods who look like the shepherds, warriors, or kings from their working environments. Both the scientists and the priests behave in fundamentally scientific ways: they accept sensory data, compare it with stored data, and then act on the macrocosm according to their conclusions. That which the scientist considers to be moving air, the tribal priest considers to be spirit. Under primitive living conditions, the priest's model is useful, and sufficiently accurate. It is enough to seek shelter from the enraged spirits; one need not know their molecular composition to do so.

Going deeper into the bowels of epistemology, we find another indeterministic muddle:

> Characteristic of classical epistemology is the skeptic-dogmatist controversy. The skeptical trend in classical empiricism invokes the restriction of sources of knowledge to sense experience only to show that there is no authoritative source of knowledge whatsoever: even sense experience is deceptive, and therefore there is no such thing as knowledge. The ultra-dogmatist wing of classical empiricism maintains that it can recognize—like God—the truth or falsehood of theories; the ultra-skeptical wing that knowledge, and therefore, rational action, is impossible.[472]

As portrayed in this passage, neither the skeptics nor the dogmatists seem to know the purpose of assumptions. The skeptics have learned correctly that there is no *a priori*, no unchangeable starting point from which all knowledge flows, but that does not mean that knowledge is therefore impossible. The dogmatists have learned correctly that theories can and should be evaluated rigorously, but like the skeptics, they err in denying the necessity and tentativeness of the assumptions on which their theories must be based. Here again, we have a trap for the would-be epistemologist. One cannot learn the nature of knowing by languishing in the skeptic-dogmatist muddle either.

Without understanding the mechanism of evolution, Univironmental Determinism, we cannot understand epistemology. Knowledge and evolution are inseparable. Occasionally, this realization comes to the fore: "How this need to know and understand was evolved is probably traceable to some survival-selection pressure in the primitive being that gave rise to mankind."[473] It is only common sense that, on the average, those individuals and groups who did know survived longer than those who did not. If *power* is the ability to act, and if survival requires acting, then the knowledge of how to act to survive is indeed evolutionary. The human microcosm contains within it matter in configurations that aid in this survival.

The fundamentals of epistemology are no great mystery once we have traversed the tangles of the determinism-indeterminism swamp. I suggest that the first step—radical by today's standards—is to assume for a moment that knowledge is matter and that knowing is the motion of that matter. From this standpoint a study of information, ideas, and prediction can proceed toward a fuller understanding, not only of epistemology, but also of consciousness.

Information

From the deterministic viewpoint, *information* is matter outside the biological microcosm, while *knowledge* is matter inside the biological microcosm. Indeterminists generally prefer more complicated definitions that are more amenable to philosophical obfuscation. They can hardly disagree that a trip to the library can produce physical evidence that information was obtained. But when we get information through some other means—for example, by listening to the telephone—the physical evidence becomes much less obvious and the opportunities for mystification increase.

Information and information transfer is of major concern in the relatively new discipline of *cybernetics*. Still to be decided, however, is the question of just what information is, if anything. From the beginning, the originator of this now-burgeoning field, Norbert Wiener, insisted that "information is information, not matter or energy."[474] His followers continue to support this extra-mechanical and therefore supernatural view of information, attributing to it some truly amazing "properties." For instance, Wiener's disciples have maintained, despite evidence to the contrary, that information can be transmitted through mechanical systems while remaining "unchanged, invariant."[475] These fellows seem not to have seen poor television reception or listened to a barely audible voice on the telephone. If transmission and reception are perfect, it is no wonder that the signal system is regarded as equally miraculous, "not a purely physical system."[476] We are left wondering what kinds of "things" information and signal systems are and on what basis such extra-physical "properties" might be assessed.

They cannot of course. One may hypothesize nonphysical "things," but one can never prove their "existence." From the neomechanistic viewpoint, information, like all other things or processes, is either matter or the motion of matter. Clearly, information is matter. The printed words before you are matter, and the only way you can distinguish between the symbols that comprise them is through some sensory device. The motion of photons, for example, must be transferred from the page to the eye to the central nervous system. Until some of that motion results in the rearrangement of matter in the microcosm of the brain, however, the information cannot be realized as knowledge. Contrary to the idealist's view, this transfer of information from page-to-brain cannot be 100 percent efficient. People with "photographic memories" or "total recall" may be highly efficient, but they cannot transfer information without losses any more than it is possible to transfer electric power without losses. In addition, the brain, being matter, can only store knowledge in a finite form. The brain is forced to abstract from the infinite detail of the natural object. One may memorize a poem, but one does not memorize every imperfection of the symbols with which it was written.

The neomechanistic view allows us to treat bits of information theoretically as though they were microcosms and therefore subject to the natural laws subsumed under Univironmental Determinism. Although there are numerous indeterministic approaches to information theory, two of them deserve some detailed comment. Each is closely associated with alternatives to one or more of the Ten Assumptions of Science.

In the chapter on *complementarity* I discussed the indeterministic weaknesses in the systems view of the Second Law of Thermodynamics. Leaning on precisely those weaknesses, P. P. Kirschenmann, a typical cyberneticist imbued with systems theory, ripped the concept of information from the material world. The core of his roundabout argument was as follows:

> [T]he order which is due to human activity is not an opposite of … "disorder." Senseful order cannot be measured in terms of its physical entropy. The physical entropy of a system is strictly dependent on the temperature, which is not at all the case for a senseful order. Sensefully ordered elements (alphabetically ordered books; words ordered into a meaningful sentence) do not have to differ in their physical entropy from a meaningless ordering of the same elements. The "double nature of information" thus touches on two aspects of man: he can know and he is a physical system. Since information processes—as the gaining of knowledge or as signal processes—occur only in connection with such a privileged system, they are not independent and, therefore, are not ordering factors in the cosmos as a whole.[477]

Thus, for Kirschenmann, "the 'storage of structural components' is no physical process, let alone a 'negentropic' one."[478] Relying on the conventional interpretation of thermodynamics, Kirschenmann sees no difference between the entropy of meaningful sentences and that of jumbled letters of the alphabet. He can do this, however, only by isolating his information system from the macrocosm—even from himself. Not realizing that the concept of order-disorder is purely subjective, he finds no more "objective" order in the sentence than in the jumbled letters. His relationship to the letters is the same in each case, precisely because he imagines that a relationship does not exist. Kirschenmann probably would say that as I type these words, I expend no more energy than if I typed gibberish. But the microcosm of the hand does not type without the macrocosm of the brain. Any writer knows that it takes a lot more energy to think up words and type them than to type gibberish. I cannot vouch for Kirschenmann, but my subjective feeling is that at least this part of the universe will be slightly more orderly after I am finished than when I began.

Sophisticated indeterminists, being unsure of what information is, readily associate it with the supernatural. And because information gathering and processing is a human activity, this gives, in their view, a mystical, supernatural quality to humans, too. For such folks, an explanation of information in physical terms is sure to be inadequate.

Kirschenmann's attack on materialism ostensibly relied on the narrow, systems view of thermodynamics, but, in actuality, thermodynamics is only peripheral to his objection. If his argument, based on ***noncomplementarity***, was shown, in great detail, to be incorrect, this would not prevent him from skipping to some other indeterministic weapon in a future offensive. His use of the classical, systems view of thermodynamics is only incidental to the basic philosophical antagonism revealed in a later passage:

> Whenever an indication is detected in science which seems to contradict spiritualistic and idealistic views, it is immediately proclaimed as a confirmation of materialist monism. Such a conclusion would be correct only if philosophy in fact were divided into two mutually exclusive camps.[479]

Dismissing *interconnection* once more, and embracing ***absolutism***, Kirschenmann looks for clear-cut distinctions in philosophy. Finding none, he rejects any distinction altogether. His real goal is not to rid science of spiritualism, but to include it wherever possible.

The adoption of ***separability*** in physics has inspired still other cyberneticians to develop theories that consider knowledge and information not as matter, but as motion. Prominent among them is Karl Deutsch, who asserted that "knowledge is a physical process, or rather a particular configuration of physical processes"[480] and that "*information* can be defined as a patterned distribution, or a *patterned relationship between events*."[481] Appealing as this may be to the conjurors of matterless motion, it brings with it obvious problems. For instance, it would forbid our everyday treatment of information as matter. Just think, we would not be able to get information from our files. Books would have to be considered processes, not things. Their reality would have to be denied and we would, in effect, have come full circle back to ***immaterialism***.

In univironmental analysis we consider that information, like other microcosms, moves from place to place, losing or gaining matter or motion. As mentioned in chapter 3 on the Ten Assumptions of Science, facts, when considered as matter, invariably lose the absolutivity generally accorded them by indeterminists. Facts, like all other things, must be viewed in context, and since all univironments are always changing, we do not expect the microcosm of a fact and the macrocosm in which it exists to be unchangeable.

Because there are no absolute facts, no information whatsoever that is not contextually dependent, there can be no absolute truth. Truth, like the facts on which it is based, cannot exist in isolation. If anything, truth is a univironment. As scientists we judge a fact as "true" only by its concordance with the macrocosm. In practice, truth is the relation between the microcosm of knowledge, and the macrocosm of information. Thus the "truth" varies from person to person. Nonetheless those who "have the facts" or have "the most relevant information" are generally considered to be closer to the truth than those who do not. As David Joravsky said: "Of course the world's scientific communities cannot claim absolute truth, but they can fairly claim that they are closer than anyone else to genuine knowledge concerning their particular fields of inquiry."[482]

If we wish to know the "truth" about the motions of a particular portion of the universe, we consult an expert on that portion. The truth about geology, for example, may be obtained from someone who is especially capable of relating facts about geology to the main features of the macrocosm in which those facts exist.

Ideas

The mere addition of another book to the shelf may increase one's store of information, but without an interaction with the human microcosm, the information in the book never becomes knowledge. What is required is a convergence of the motion of matter of the information in the book with the brain. In the brain, knowledge from one place invariably meets knowledge from another. We may speculate that disparate facts, like other kinds of matter, eventually produce chemical reactions within the brain that we experience as mental conflict. As with other univironmental interactions there are only two possible outcomes of such clashes: divergence or convergence. In the first, it is as though the physicochemical counterparts of the conflicting facts move to different parts of the brain. This activity seems analogous to the behavior of the agnostics who put the *Old Testament* on one shelf and *The Origin of Species* on another to avoid the mental anguish provoked when they see them side-by-side.

In the second, new combinations—ideas—result when the contradictions between facts or theories are reconciled. This can be done by emphasizing the similarities between the two facts or theories and deemphasizing—trying to forget—the dissimilarities. Sometimes this leads to the rejection of nearly all the features of a fact, as when either creation or evolution wins the mental conflict. At other times, major portions of both facts are accepted and major portions are rejected to reach a compromise. An example of this synthesis occurred when, still a believer in the expanding universe theory, I was thinking about what its opposite, the oft-hypothesized contracting universe, might be like. As my brain switched back and forth between these two seemingly opposed concepts, it lingered momentarily on the idea that the universe may be both expanding *and* contracting at the same time. Taken literally, of course, this would be absurd.

Nonetheless, the assumption I eventually used to resolve the conflict, *complementarity*, contains elements of that ostensibly illogical combination: portions of the infinite universe actually do diverge (expand) from one place at the same time that they converge (contract) on another.

Although the generation of ideas is often mystified and exalted as the province of only a few "creative" people, it is basically simple. First, it requires an accumulation of information from disparate sources. Second, it requires a reconciliation of the disparities in this information, generally through a search for the similarities between seemingly contradictory facts. The idea or theory that results is the common thread that links the facts.

The magnitude of the idea to be generated is dependent on the magnitude of the disparity it must resolve. Einstein spent two decades trying to discover a unified field theory. The effort failed, most likely not because the disparities he was working with were too large, but because they were too small. Gathering more and more information within his narrow specialty was insufficient and only amounted to a recycling of facts that were similar to what he already knew. What he needed was much more widely disparate facts that would have magnified the contradictions within his Special and General Theories, perhaps even calling some of his erroneous assumptions into question. The outcome of such efforts would have been the transformation of his "successful" theories into "unsuccessful" ones—an unlikely task for one so profusely honored for those same theories. The solution to Einstein's problem would not be found within the narrow discipline of physics, as it was then constituted.

There are two basic approaches to problem solving: the microcosmic (deductive) and the macrocosmic (inductive). In the microcosmic method we use the materials close at hand, those within the confines of the microcosm of the problem, as we know it. The microcosmic approach works especially well with simple mathematical problems and with simple puzzles in which all possible combinations only need to be tried until success is achieved. The solutions to most mechanical or instrumental failures are of this type—when the tools, the parts, and the knowledge are available. The microcosmic approach normally is the first to be tried in solving any problem because it generally is the most efficient, the vast majority of current difficulties being similar to previous difficulties.

It is only after the microcosmic approach has failed repeatedly that we are likely to broaden the search. With macrocosmic thinking (induction), we search for materials normally not considered within the confines of the microcosm of the problem. This approach, although often inefficient, is potentially the most creative. Even its failures are less exasperating than deductive failures that usually amount to mere recycling of old information, degenerating eventually to little more than worrying. Whenever thinking reaches that point, the next step is to interact with the macrocosm to gather more information.

Macrocosmic thinking is neither wholly random nor without microcosmic, theoretical guidance. On the other hand, according to *relativism* it is impossible to find information having absolutely no bearing on a problem. This is because no part of the universe is completely dissimilar from any other part. As philosopher of science Scott Buchanan keenly observed, "All method directly or indirectly leads to understanding."[483] It does not follow, however, that all methods are equally efficient or that one needs no method at all as claimed by strict empiricists and celebrated anarchists.[484] In the realm of thinking that would be akin to having a macrocosm without a microcosm.

Of course, different methods produce solutions at different rates—that has been a major point of this book. But even the dullest investigator, when asked to make observations, measurements, and interpretations, will succeed at least to some degree. Any sentient being can be a scientist. The actions carried out during an investigation cannot be reversed or undone. We always learn something, if only that our methods and theories are inadequate.

We also may speculate that new ideas appear as new brain states—actual physicochemical combinations or material interconnections that have never occurred before. New ideas, like other new tools, give physical evidence of their existence when the human microcosm inevitably interacts with the macrocosm in new ways. Indeed, it would be methodologically impossible to prove that an idea or particular brain state did not influence the macrocosm. The test for the existence of an idea itself requires a univironmental interaction. An idea influences the actions of its holder. These actions, in turn, influence the sensory systems of other people with a facsimile of the original idea being carried forth through the macrocosm.

Very few new ideas find ready acceptance. Acceptability depends on two factors: the state of the macrocosm to be influenced and the effectiveness of communication. Everywhere people are waiting to receive information. They hunger for it. Their survival depends on it. But what they actually receive and retain depends on their brain states, too. If an idea requires building blocks X, Y, and Z, it cannot be accepted by an audience having only building blocks A, B, and C. Great dissimilarities in language, vocabulary, philosophy, and other aspects of culture automatically retard the acceptance of new ideas. Of course, that an idea has evolved at all generally means that similar building blocks exist elsewhere in the world. There are few ideas that would not be acceptable to at least a few other people. Similarly, no one person can be considered essential to the development of an idea of any significance. This is shown repeatedly by scientific discoveries that occur almost simultaneously in different places. Similar ideas are bound to evolve through interactions within similar univironments.

Prediction

It is only through success in predicting the future that the brain, knowledge, information, and ideas are of any use. Prediction is possible because all microcosms are to a degree similar to all other microcosms. Prediction is necessary because all microcosms are to a degree dissimilar from all other microcosms. Most of our predictions are done subconsciously. They never see the light of day and are evaluated haphazardly if at all. With the evolution of the scientific method, the human microcosm learned to consciously and overtly insist that important ideas be tested through interaction with the external world. The Scientific Worldview denies the possibility of Hegel's absolute idea, a microcosm that is perfect, unchangeable, and therefore incapable of interacting with the macrocosm.

The materialistic conception of the idea allows us to avoid such mistakes of indeterministic philosophies and to treat the idea as we do other microcosms. Because the idea forms through the convergence of matter and the motion of matter, it *must* have a material realty. Like other microcosms, the idea evolves through Univironmental Determinism; always, it moves toward univironmental equilibrium. The evolution of an idea cannot be disconnected from the human microcosms that possess it. Sometimes an idea is destroyed along with the brain in which it was conceived. At other times an idea survives, as do other microcosms, because it exists in relative accord with its macrocosm.

The idea is like a map that, for a limited distance, shows the way through the maze of the macrocosm. The idea, the model, the map, exists so long as the microcosm guided by it circumvents the obstructions it is sure to encounter. The idea, the model, "predicts" so long as it exists. But the idea is finite. Existing in an infinite universe, it eventually converges on the unexpected, and at that moment, the idea, the map, becomes useless and is destroyed. Even this, however, is not always the end, for the idea interacts with the macrocosm throughout its history. In the macrocosm there may be eyes that see the destruction of the idea: how it came to pass that the idea, the map, eventually failed to show the way, how the idea led to the "wrong" path in the maze of the infinite universe. The watchers in the macrocosm need not repeat the same mistake.

Ethics

No philosophical study of the human microcosm is complete without at least a short discussion of ethics. My purpose here is not to outline an ethical code, but to sketch the scientific view of the nature and evolution of such codes. Like the other concepts associated with human consciousness, ethics have been heavily mystified. The search for the absolute idea has been generally accompanied by an equally feverish search for an absolute, unchangeable code of ethics. Such a code has never been discovered. Whenever some claimed they had found it, others claimed they had lost it. If we have learned anything, it is that all the while priests and philosophers talked and wrote about ethics, people were busy making them.

Ethics are guides to the relations between people and groups of people; they continually change as the relationships between people change. An objective discussion of proper ethics is a contradiction in terms. Conservatives tend to ground their defense of the status quo in ***absolutism***, while progressives ground their suggestions for change in *relativism*. While the rigidity of early codes may have been functional for traditional cultures, rapid technological change has required dramatic modifications in ethics during the last few centuries. The formal excuse for the latter was articulated as the principle of ethical relativity.[485] Its conservative enemies often vulgarize ethical relativity as the idea that "anything goes," but that, of course, is nonsense. It is the business of ethics to predict what goes and what does not go.

Ethical ideas, like all other ideas, exist within a particular univironment. Similarly, ethics and morals provide a map or model of the macrocosm, a guide to action ignored only at one's peril. The rules of ethics are resistant to change just as they are changeable. Puritans need not fear the release of the untrammeled human spirit, just as libertarians need not fear the permanent stifling of their desires.

Much indeterministic nonsense has been written about ethics and morals from a supposedly scientific perspective. Max Planck, for instance, thought that, "moral responsibility … has nothing to do with the law of causality. … It is a dangerous act of self-delusion if one attempts to get rid of an unpleasant moral obligation by claiming that human action is the inevitable result of an exorable law of nature."[486]

Likewise, be cautious about the stuff from Reichenbach: "Since actual man, in general, does not behave morally, it seems quite clear that ethics does not deal with the actual behavior of man."[487] And surely don't give up all hope along with David Hume, who said that "the distinction of vice and virtue … is not perceived by reason."[488]

Don't believe Dorothy Nelkin when she says that the modern theory of ethical relativity requires an indeterministic universe.[489] Neither "immoral" behavior nor "moral" behavior is irrational and ungoverned by material causes despite what the people from Copenhagen say. Even the indeterminist Ernst Cassirer saw the folly of divorcing the analysis of ethics from the law of causality: "[I]t would be fatal for ethics to tie itself to and, as it were, fling itself into the arms of limitless indeterminism. From such a standpoint we would have to evaluate an action more highly, the more it bears the earmark of the arbitrary, the unforeseen, the unpredictable."[490]

A prominent characteristic of ethics in a rapidly changing society is that there often appear to be as many exceptions as there are rules. Convergence continually produces new situations, resulting in moral dilemmas. Children are taught to love their parents and to hate thieves. But what are they to do when they find out that their parents are thieves? They obviously cannot love their parents more without hating thieves less. And so morals develop exclusively in the social context. Criminals, for example, often do not steal or kill within their own group even though their survival within the greater society may depend on stealing and killing. People were slaughtered in the Christian crusades and the Inquisition, ostensibly to spread a moral code that included a sanction against killing. The contradictions abound.

Indeterminists usually have difficulty explaining the origin and evolution of morals. The received view can be extraordinarily naïve. "A morality sustained by belief in rewards and punishments, is rotten at the core."[491] The belief in ***acausality*** implies that morals might arise out of nothing or be received from a nonmaterial being. They certainly could not be physical entities and certainly could not result from physical interactions between the human microcosm and the macrocosm.

Although confused about causality, Reichenbach nonetheless thought "the ethical orientation of human society is a product of mutual adjustment"[492] and that ethics are a "result of the struggle of opinions … through the friction between the individual and his environment."[493] In other words, ethics reflect the power relationships in society. If you do not have the power to obtain the food you need, someone who does is sure to propose an ethical code justifying your misfortune.

Perhaps because they are generally favored in the power structure, indeterministic philosophers characteristically deny the part played by power in the formation and preservation of the moral code. Thus the dualist Hegel wrote that "Coercion and enforcement belong to the world of nature, not to the world of freedom, which is the world of morality."[494] The reality, of course, is different. Neither our hands nor our brains have produced a world in which the ability to act is banned. We can only hope to be spared from those twofaced moralists who, following Hegel's idea, aim to establish a morality without force, even if they have to kill to do it. As Pareto acknowledged, "The 'right,' claimed by people who bestow on themselves the title of 'civilised' to conquer other peoples, whom it pleases them to call 'uncivilised', is … nothing other than force."[495]

Any person or any group that unilaterally promulgates a moral code may be rightfully charged with committing an ethical offense. The hidden purpose of many a code has been, as Zipf put it so bluntly, to "hallow elite positions and to hoodwink the pariah class."[496] Such deception is especially prevalent in the mixed bag of ethical codes we live with today. Particularly noticeable is the lucrative morality of the "self-help" genre that is proclaimed for aspiring capitalists while the submissive morality of Pauline Christianity is foisted upon the workers. Since the morality of self-help is more recent than that of Christianity, and often seems to be the way things are going, it is worthwhile to examine a bit of it in detail. In typical fashion, R. J. Ringer says:

> When you say someone is "dishonest," what you really mean is that you and he differ in your definitions of honesty. This doesn't mean his moral standards are lower than yours; they're simply not the same. And if that person thinks your moral standards are lower than his, that's his problem. It's not your job to look out for him; your job is to look out for Number One. … Your moral standards should be what you define them to be. Don't allow others to be so presumptuous as to set them for you.[497]

There is no doubt that such homespun subjectivism has a certain appeal—numerous best sellers indicate as much. And it is true, as Ringer points out, that moral codes are relative; no two are identical. Beyond this, however, Ringer, and others like him are neovitalistic dreamers, insisting that what others think about their actions cannot or should not have any effect on them. In the spirit of systems philosophy, Ringer rips the individual from the social context and sees the human microcosm free of the macrocosm. He implies that morals are "self-generated" and thereby acausal. They are formed in a vacuum and nothing anyone does or says can affect the moral standards of Ringer's asocial phantom.

Science and Ethics

Anyone who studies ethics does so to preserve them or to change them, and, in so doing, changes them. The question often arises about the contribution, if any, that might be made by the "objective" approach for which science is often revered. Typically, scholars in the humanities deny that ethics can be based on natural science,[498] while a few scientists have claimed just the opposite. According to Hardin, "We will never solve the moral problems of men until we accept, in our bones, the insights of the biologist and the geneticist."[499] I can't wait.

Unfortunately, such "scientific" insights usually sound vaguely similar to those of the absolute moralists. An energetist, for example, once proposed a new moral "absolute" based on thermodynamics: "waste no energy."[500] How appropriate this might be as a slogan for those who today believe that all the world's problems revolve around energy!

Some of the classical mechanists translated their belief in ***finity*** into a belief in ethical absolutes that were supposed to be valid for all time. Jacques Loeb suggested a few: the "instinct of workmanship," "the love of a mother for her children," "the struggle for justice and truth" arising out of the compulsion "to see our fellow beings happy."[501] Nice sentiments for sure, but are they really absolutes? Read the front page of almost any newspaper and you will find out. The exceptions, once again, abound. It seems that we don't live in Loeb's hypothetical world. As long as some products are imperfect and some children unloved, Loeb's absolutes will be relatives. As long as not everyone can view the universe from the same set of shoes there will not be complete agreement on anything. And that is precisely why ethics never can be absolute no matter how good they sound. Viewing the world from different space-time positions, we do not see the same things. For each of us, the "main features" of the univironment are unique. In short, there is an inevitable and ongoing conflict about what is important and what is unimportant. Ethics do not escape this fact.

Other scientists have been willing to grant that there could be conflict all right, but only between competing ideologies. For G. G. Simpson, a noted authority on evolution, ethics did not involve ideology and thus are conflict-free, absolute, and derivable by scientific methods. "The broadest problem now facing mankind is choice between conflicting ideologies. These evolutionary ethics here lead to unequivocal decisions. Authoritarianism is wrong."[502] Still other platitudes got Simpson's "scientific" benediction. "It is immoral for any man, industry, or a nation to reserve knowledge for its own advantage alone. The inequity of knowledge is in itself unethical and is one of man's great blunders. It could be his last … it is wrong to develop one individual at the expense of another."[503]

One can hardly disagree with most of these as general, ideal goals for humanity. Whether they can be observed in reality is another thing. These statements are no more scientific than those of other moralists even though eminent scientists made them. They are "maps" of the external world that give instructions on how to negotiate that world. Being stated in authoritarian terms and distributed widely, they constitute an aggressive means by which these scientists sought to transform their environments. Whether you see such pronouncements as good or bad depends on how accurately they portray the world from your vantage point.

We may doubt that the ethical conclusions of professional scientists are any more useful than those we devise ourselves. To reiterate: the observation that different people come up with different ethical maps only demonstrates that each human microcosm exists in a unique space-time position. Because the development of ethics is an everyday human activity, we need not defer to the "specialist in ethics" for its determination. Our ethics are a result of all that has occurred in our past, not something we make up willy-nilly in spite of it. Self-helpers avoid ostracism to the extent that they have received responsible ethical training before adopting their dubious creeds. Morality is the inevitable result of past and present univironmental relationships that are not dependent on innate altruism or on an equally mysterious "free will."

Altruism

As the title of Richard Dawkins book, *The Selfish Gene*,[504] revealed, neo-Darwinians have trouble with the other side of the social contract: altruism. When humans are viewed as systems, their connection to the macrocosm becomes ambiguous. Thus from the systemic viewpoint sociobiologist E. O. Wilson could claim that "social control would rob man of his humanity."[505] Like other indeterminists, Wilson forgot, or perhaps never learned, that social control is the distinguishing feature of culture. Social control is obviously what ethics are all about.

So much of ethics is unwritten and often does not appear to be social control at all. The actions produced by this kind of control generally do not have obvious causes and therefore are particularly liable to be termed "altruistic." For the indeterminist, altruism is a microcosmic, absolutely unselfish regard for the welfare of others. For the univironmental determinist, altruism is an inevitable result of preceding univironmental interactions. The indeterminists' linkage of altruism with ***acausality*** is based on ignorance, for when faced with the questions "where does it come from?" and "how do we increase it?" indeterminists, by definition, cannot have satisfactory answers.

For decades indeterminists have argued that there are genes for altruism. According to sociobiologists, altruism can be inherited in the same way as physical traits such as body size and hair color. Instead of viewing altruism as a univironmental interaction, they view it as a property of the microcosm. It is the neovitalist story all over again. But if the movements of microcosms are in every case toward univironmental equilibrium and if only one reaction is possible for each movement, then actions seen as altruistic must be regarded as the only ones possible under existing conditions. Each microcosm provides a macrocosm for other microcosms. By its movements, each microcosm controls the movements of others.

Humans are no exception. Our actions, like all actions, can be viewed as either selfish or altruistic. Some have even considered tact to be a competitive weapon.[506] But it all depends on the observer's point of view. As Whitehead said in one of his better moments, "Every organism requires an environment of friends, partly to shield it from violent changes, and partly to supply it with its wants."[507]

It is no accident that the behavior of a microcosm appears less and less altruistic as its activities involve those normally at greater and greater space-time distances. Sociobiologists have interpreted this as a genetic rather than a spatial relationship. By their reckoning your genes somehow prompt you to be the most altruistic to those with whom you share the most genes in common. These little buggers are said to be so powerful that they will make you be more altruistic to a sibling than to a second cousin, even though you may associate with your second cousin every day and your sibling once every ten years. Don't laugh. Some people actually are believing such junk at this moment!

It is true that genetic relationships can be demonstrated for certain properties of the microcosm that are associated with altruistic acts. The mother understandably cannot feed the young without the physique to do so. Nevertheless, the hand that rocks the cradle is also capable of pulling the trigger. To hear the sociobiologists tell it, the decision to do one or the other is itself inherited and would be translated into action regardless of the specific nature of the macrocosm in which it occurs. The propensity toward altruism cannot be a property of either the microcosm or the macrocosm.

The real aim of the sociobiological analysis of altruism is a weather-beaten political one: to furnish the pretext for relegating the responsibility for social control entirely to the individual. Social responsibility cannot respond to that approach. As reciprocal interactions between the individual and society, the production and sponsorship of altruistic acts are the obligations of both. Society can sponsor those actions it considers altruistic by providing the kind of macrocosm in which altruism is likely to occur. Admittedly this is a lengthy process in which the macrocosm fulfills only half the necessary conditions.

People who have evolved in macrocosms that produce "selfish" or "inner-directed" people[508] are unlikely to display many altruistic or "other-directed" actions even under conditions especially designed to produce them. Nevertheless, as human microcosms, over the long term we become more and more like the macrocosm in which we exist while the macrocosm becomes more and more like us. Thus, the first generation thrust into a densely populated urban environment finds the new kinds of altruism demanded of them to be an almost unbearable chore. To subsequent generations it becomes "second nature."

Indeterminists of the utopian variety insist that "our passionate convictions need not be rationalizations of self-interest."[509] They resist interpreting altruism as a univironmental interaction. For the true utopian dreamer, "Life would not need to be a 'permanent, unremitting struggle' at least not a struggle between personal and social interests and values."[510]

Like Berkeley, they call for a completely subjective world in which microcosms do not have to interact with the macrocosm—a world that does not and cannot exist. In a way, we are fortunate to be spared such a utopia, for it is one in which univironmental interactions could not take place. If we didn't like this ready-made kingdom (whatever that would mean without interaction) there would be nothing we could do about it. Such a "heaven" would be an absolute dictatorship.

Univironmental Determinism and the Human Microcosm

In social science, univironmental analysis provides the proper point of departure for studying and demystifying the infinitely complex phenomena associated with human activities. The basic point of this chapter is that humans are microcosms too: portions of the universe, matter in motion. Like all other microcosms, humans move in response to the infinity of matter in motion within and without. The direction of that motion is toward univironmental equilibrium, the least amount of motion of the microcosm and the macrocosm. But both the microcosm and the macrocosm are continually changing, and thus univironmental equilibrium is only temporary.

We have seen that the primary error that systems philosophy imposes on social science is its tendency to attribute univironmental relationships to the human microcosm alone. Thus, human needs, the stimulus for all human behavior, are considered from the systems perspective as properties of the person rather than as properties of the univironment. But all behavior is the motion of microcosms with respect to the various parts of the macrocosm in which they exist. Needs are not fixed, but keep changing as univironments change, therefore making it difficult, yet increasingly necessary, to predict the behavior of others in our evermore socialized environment.

Univironmental analysis of the perennial heredity-environment debate shows it to be a vast, pointless muddle of more interest for its politics than for its science. Hereditarians overemphasize microcosmic factors and environmentalists overemphasize macrocosmic factors. The right wing, racists, geneticists, biologists, and systems philosophers tend to be hereditarians, while the leftwing, antiracists, sociologists, historians, and mechanists tend to be environmentalists. The proper, univironmental, analysis views genetic inheritance as a small but important part of the human microcosm that, in turn, interacts with the macrocosm. Again, neither the microcosm nor the macrocosm is more important than the other for evaluating the motions of the microcosm.

Univironmental analysis also provides the resolution of the mind-brain muddle, without which the nature of consciousness remains a mystery. The mind is the motion of matter within the brain. Sensory motion from the macrocosm is neomechanically transferred to the brain where it alters the brain's physicochemical properties and is thereby stored as knowledge. The process of knowing and the act of being conscious is a result of the motion of these physicochemical counterparts of information. Ideas and predictions thus form through the neo-mechanical interactions of actual physical entities.

Univironmental analysis also sheds light on the problems of ethics and altruism. Ethics are material representations existing in the brain of each person. They act as guides or maps to social behavior. Like all other forms of matter, ethics are forever alterable, changing as the univironment changes. Ethical behavior results in apparently altruistic acts benefiting other microcosms. Univironmental analysis shows altruism to be, not a property of the microcosm, as the sociobiologists assume, but a univironmental interaction in which the motions of the microcosm appear to benefit the macrocosm. Altruistic acts are promoted by changing the microcosm or the macrocosm. This relationship between the human microcosm and the macrocosm is one of many reciprocal interactions leading to the higher evolution of the Social Microcosm, the subject of the next chapter.

Chapter 12

The Social Microcosm

> The form of society is determined by all the elements acting upon it, and in turn it reacts upon them. There is therefore a reciprocal determination.[511]

For the indeterminist, there is no telling what humans, endowed with "free will," might do. Multiplied by billions, the sheer numbers only make it worse; "There are imponderable currents that make us all slaves of the obscure seethings of the human mass."[512] But for the determinist, each human microcosm is, in turn, part of *the* Social Microcosm, humanity itself. Our lives and the life of the Social Microcosm are anything but imponderable. They are not influenced by free will or by anything other than matter in motion within and without. The "seethings" of the Social Microcosm remain obscure to the degree that we have not yet discovered the causes for them, not because the causes do not occur. If Chardin's "obscure seethings" are to be understood at all, we must reject the anthropocentrism of conventional thinking that invariably produces a lopsided picture of humanity and its place in the universe.

The Social Group as a Microcosm

According to the Scientific Worldview, any human group is a social microcosm. The evolution of social microcosms, like the evolution of all microcosms, is controlled by the univironment: the motion of matter within and without. As with all other microcosms, a holistic or synergistic effect arises whenever two or more converge. The denial of this simple truth, however, has become a special characteristic of Western culture and social analysis. While capitalists benefited from the increased efficiency gained by organizing workers in centralized workplaces, they systematically propagandized workers against forming social combinations that would produce a similar effect in obtaining labor's share of the increased productivity. Both classical mechanism and systems philosophy raised few objections.

For classical mechanism, wholes were equal to the sum of the parts. Unions had no properties above and beyond those of the individual worker. For systems philosophy, the preferred system was the individual even though nothing except prejudice kept it from considering the group as a system instead. Being biased in favor of the system, modern philosophy tends to view synergistic effects as the results of interactions between subsystems. But systems, by definition, are self-acting and isolated. When systems philosophy isn't emphasizing the turmoil within individuals, it emphasizes the turmoil between workers. The critical relationship between labor and capital is almost forgotten.

Much of the modern propaganda against the powers of social organization is contained in bestselling books of the self-help genre. The authors of these solicited tracts almost always promote the non-holistic, pessimistic view of group action. From Hugh Miller[513] to Robert Ringer, the message is pretty much the same: "joining a group to accomplish any purpose is irrational."[514] Over and over again, self-help authors incredulously rediscover that you "lose a certain degree of individuality the moment you take part in group action."[515] These alienated chaps seldom admit to being part of and seeking the advantages of any social microcosm. They only seek to avoid membership; "the best way to help the poor is by not becoming one of them."[516] The implications: although the poor are always with us, they are poor of their own free will. They need only "will" the macrocosm away to escape from poverty.

Despite such immaterialistic fabrications, we all enjoy group membership, finding solidarity based on our similarities with other microcosms.[517] Moreover, we discover our individuality only by comparing ourselves with the members of various groups. In even the simplest of descriptions we must regard ourselves members of one class or another. To be tall, dark, and handsome does not admit of being short, light, and ugly. Social microcosms, like all classes, are whatever we define them to be.

Sometimes a social microcosm is easily defined. The geographic or political boundaries between states, for example, can give concreteness to the univironmental analysis of social microcosms. Nonetheless, the boundaries between social microcosms can remain abstract—concrete ones are not required for the analysis. The social microcosm of "tall people," for instance, may be understood notwithstanding its spatial intermixture with the social microcosm of "short people." This intermixing of one microcosm with another tends to bother idealists, but scientists are confronted with it regularly. For example, in mineralogy the isomorphous substitution of one chemical element for another often results in a continuous series in which only intermixtures occur.[518] The microcosm of one mineral can interpenetrate the microcosm of another—they are more easily separated conceptually than physically.

The univironmental analysis of a social microcosm is fundamentally no different from any other analysis. Although the selection of univironmental boundaries, as always, is inherently subjective, it must meet the same criteria we use in the analysis of other microcosms. The only way we can find out whether we have chosen the correct univironmental boundary is to compare our observational and experimental results with our predictions.

Indeterminists tend to believe that social microcosms are a jumble of happenstance, but even a few generalizations demonstrate that they are not. The spatial distribution and the interactions of people are never accidental, but, like all things and all events, they are the results of what came before.[519] Within particularly dense populations, such as those in cities, the social microcosm is readily apparent. It spreads its traffic and communications arteries, connecting its vital central elements with the surrounding countryside where the distinction between the urban and the rural remains diffuse and arbitrary because, as always, there is a continuum between the two.[520]

Every one of the decisions and events leading to the formation of a social microcosm is determined by the univironment. The pioneer says, "If I build a house here, then I will have to walk only so far for water and only so far for firewood." The suburbanite says, "If I build a house near the freeway, I will have to drive only so far to work and only so far to the grocery store." As Zipf showed, all our planning is motivated by the desire to minimize human effort.[521] We habitually look for the parking space closest to the entrance to the store. That is, unless we wish to forego the effort that it would take to reclaim a body failing for lack of exercise.

The social microcosm, like all other microcosms, moves in only one direction: toward univironmental equilibrium. As Ellen Semple observed long ago, "The area which a race/people occupies is the resultant of the expansive force within and the obstacles without."[522] The peculiar characteristics of a social microcosm arise in semi-isolation; "A land shut off by mountains or sea from the rest of the world tends to develop a homogeneous people, since it limits or prevents the intrusion of foreign elements."[523]

These characteristics change when that semi-isolation is inevitably broken. The movement toward uniformity, the mixing within, tends to hold a social microcosm together, while the movement toward diversity, the mixing of the within with the without, tends to break it apart. Thus it is the conservative center that holds the social microcosm together, while the liberal margins change it. In the past, those who lived in the central portion of a country traditionally were more conservative, more secure, and less adventuresome than those on the periphery.[524] Whenever the microcosm of each nation was stimulated by events in the macrocosm of the world, their impacts were noticed first at the geographical and political boundaries of the country. With the advent of jet travel and global communications, the macrocosm enters conspicuously from yet another direction. The old boundaries are becoming less meaningful and old-style conservatism lies exposed at the core. The result: cultural war, red states vs. blue states, creationism vs. evolution, religion vs. science.

Social microcosms have existed for more than three million years, but their appearance as microcosms becomes especially evident now as even the most sluggish of them swings into action. Ironically, the idea of social microcosms becomes more obvious as the boundaries between them become more abstract. This is part of a greater evolution in which social microcosms that were once relatively isolated now join more fully in the evolution of *the* Social Microcosm, humanity itself. The birth of the Social Microcosm, like the birth of all microcosms, is the story of a great convergence. It begins with a consideration of the two possibilities for converging microcosms.

Competition and Cooperation

As I have assumed under *complementarity*, each microcosm is continually moving toward other microcosms and away from still other microcosms. Obviously, without a convergence of two or more microcosms, no new thing, no new microcosm can arise. In a truly expanding universe, one in which only divergence occurs, the evolution of the Social Microcosm would be impossible.

But we actually live in an infinite universe, one in which convergence is just as common as divergence. For us personally, and certainly for the publicists of the expansion hypothesis, convergence is not always pleasant. No two microcosms can occupy the same spatial position, a commonsense observation formally recognized in biology as the Competitive Exclusion Principle.[525] Convergence initially brings about *competition*: the struggle of microcosms for identical spatial positions. Of course, nothing new would arise if all microcosms simply converged, competed, and then diverged again. New microcosms could arise only if microcosms did not completely diverge from one another. This amounts to a sharing of nearby spatial positions, a phenomenon otherwise known in social science as *cooperation*.

In the most fundamental terms we discuss this phenomenon under *bonding*: "a mechanism by which atoms, ions, or groups of atoms are held together in a molecule or crystal."[526] Unfortunately, for modern physicists, bonding is as mysterious as its analog, gravitation. Both have been vulgarized by the microcosmic hypothesis of attraction. Thus, to view cooperation univironmentally, we must first return to neomechanics to build correctly from the simplest possible case.

Neomechanics of Bonding

In the strictest sense, classical mechanics could not explain the development of bonding in mechanical terms. Finite, inelastic Newtonian bodies converged, but the consequence of their collision was a mere transfer of motion from one body as a whole to another body as a whole. Being inert bodies, that is, without other bodies inside them, none of the motion of impact could be absorbed internally—all was used in sending the impacted body on its way unimpeded by other microcosms in the surrounding "empty space." Nothing new could come of that. But as in the exegesis of gravitation, classical and systemic explanations of physicochemical bonding invariably were forced to include some form of the hypothesis of attraction.

For classical mechanics attraction was an afterthought, but for systems philosophy it became the main show. Bonding in humans, as in molecules, was seen as a sort of mysterious mutual attraction of matter for matter. People joined in social groups simply because they were "attracted" to each other. Of their own equally mysterious free will, they came to desire social collusion. And as the self-helpers insisted, they could just as easily reject it.

For classical mechanics, the tendency to bond was the result of the inertial collisions of bodies; for systems philosophy the tendency to bond was the result of the mutual attractions of subsystems. In one, human cooperation was forced; in the other, human cooperation was chosen. The reality, of course, exists between those extremes. Only a philosophy that was neither fatalistic nor solipsistic could discover an adequate explanation of bonding in molecules or of cooperation in humans. Once again, this is where that chapter on neomechanics relates to univironmental analysis.

Remember that neomechanics, unlike classical mechanics, views interacting bodies as microcosms containing an infinite number of submicrocosms within (see Figs. 5-1 through 5-6). When these microcosms collide, the motion of the whole is transferred to submicrocosms, not all of which appears again as motion of the whole. The impacted microcosm thus never leaves the scene of the collision with the momentum at which the impacting microcosm entered it. Depending on the degree of internal absorption and the resistance of the macrocosm, the distance between the two microcosms will be some finite though temporary value.

Instead of leaving the scene entirely, the impacted microcosm tarries a while, and a new combination, a new microcosm, arises. Not until the resistance of the macrocosm decreases can there be dissolution of the bond between the two microcosms.

In the previous paragraph I mentioned the "resistance of the macrocosm" as being partly responsible for determining the distance between microcosms. This is where the Univironmental Theory of Gravitation comes in. Because all microcosms are always subject to continued bombardment by other microcosms, mutual shadow casting retards their movement away from each other. Like the earth-moon combination, bonding occurs when two microcosms reach a temporarily stable equilibrium distance as a result of the univironmental interactions pertaining to each of them.

Bonding and Socialization

The simple neomechanical view of bonding helps us understand the tendency for social microcosms to move toward univironmental equilibrium. Microcosms move under their own inertia until they are slowed by the macrocosm, which, in an infinite universe, inevitably contains the additional microcosms to do the slowing. When this slowing process develops near another microcosm, a "bond" forms. All kinds of bonds—those between people, groups of people, nations, planets, stars, and galaxies, as well as those between chemical elements—are formed in fundamentally the same way; they are the result of the interaction between microcosm and macrocosm. The bonds of cooperation and socialization are born of univironments in which microcosms in combination have less motion relative to the main features of the macrocosm than they would in separation.

Like all other bonds, those of social microcosms form and dissolve at the behest of the univironment. To understand this more fully, let us return to the Law of Mass Action. Consider again the formation and the dissolution of ordinary table salt, NaCl, which dissolves in water according to the reaction:

$$NaCl \xrightarrow{+H_2O} Na^+ + Cl^- \qquad (12\text{-}1)$$

When the water is removed, sodium chloride crystals form according to the reaction:

$$Na^+ + Cl^- \xrightarrow{-H_2O} NaCl \qquad (12\text{-}2)$$

Neither reaction 12-1 nor reaction 12-2 is truly reversible, but for convenience we write:

$$\mathrm{NaCl} \underset{-H_2O}{\overset{+H_2O}{\leftrightarrow}} \mathrm{Na^+ + Cl^-} \qquad (12\text{-}3)$$

Of course, there are many dissimilarities between bonding in sodium chloride and that between other microcosms, but a fundamental similarity remains: neither the microcosm nor the macrocosm controls the process—they both do.

The above is indeed as simple as it is fundamental, but this reminder would have saved the famous astronomer, Fred Hoyle, a bit of embarrassment. In the typical style of the systems philosopher, Hoyle once speculated that the collapse of organization would be the limiting factor for human population growth. Hoyle's theory was promoted by Walter Sullivan, the famous "scientific" propagandist of the New York Times, who neatly summarized it as follows:

> It is typical of "organizations" of great complexity that they are subject to collapse. He cited the behavior of ice. It holds together until, at a certain temperature, the increased thermal motions of its molecules bring about its collapse into water. Melting is common to a great many substances, he said, and added that such collapses seem to be a common property of all organizations, irrespective of whether the individuals happen to be humans or chemical molecules.[527]

Hoyle's analogy is appropriate, but the analysis is completely wrong. You may have noticed his glaring microcosmic mistake so typical of systems philosophy. The microcosm of ice does not spontaneously melt of its own accord. Melting requires a change in its macrocosm from the one that produced it to one that will destroy it. The lesson: complex systems never collapse merely because they are complex, but because their surroundings change.

Competition Produces Cooperation

In sociology, as well as in other types of biology, the propaganda against synergism has sponsored a traditional overemphasis on the competitive aspects of evolution. This has occurred in spite of the obvious fact that microcosms must combine or "cooperate" in the first place to produce the systems that evolve. Competition is a manifestation of instability, while cooperation is a manifestation of stability. Microcosms do not speed up of their own accord. Convergence eventually produces the contact that we view as competition, and because all movements are toward univironmental equilibrium, the result is always an accommodation between microcosm and macrocosm. If competition reflects the struggle for existence, then cooperation reflects existence itself. Cooperation is the result of competition.

Indeterminists, having no clear idea of the way in which cooperation arises, are just as likely to get it backwards. Garrett Hardin, for example, once claimed, "With sociality came conflict, and as sociality became the norm conflict became an ever-present force in life."[528] For Hardin, sociality is not the result of conflict, but borders on being the cause of it: "A species can survive such an erosive force only if it evolves modes of conflict that permit competition to be worked out by means that stop far short of the lethal point."[529]

Nothing really new ever arises from Hardin's competition, for he barely can bring himself to write the word "cooperation." This leads to additional absurdities: "Because the members of a family are unequal in fact they can live together amicably … The parents, different sexes, *are* different. They can accept a child because it is inferior."[530] For Hardin, stability produces instability, equality produces conflict: "The complete elimination of classes would mean the installation of a dog-eat-dog society."[531]

Hardin is not the only one to put the cart before the horse. You probably have noticed that many conflicts, particularly your own scheduling conflicts, are resolved best by more rigorous planning. That great futurist Daniel Bell once argued that planning does not eliminate conflict—it produces it. He thought this was because planning delineates the choices available without furnishing the standards for making them.[532] Bell apparently was confused because cooperative efforts that resolve a particular conflict produce new univironments in which new conflicts tend to arise.

The continuing need to resolve new conflicts as they appear is disconcerting to indeterminists reared with Aristotle's doctrine of "final causes" and its false hope of permanence. Political reactionaries, especially, find the prospect of increased planning and regulating to be generally repulsive. The fact remains, however, that competition produces cooperation, and not the other way around. First come the traffic accidents, then the traffic signals. Bell's argument leads to the ridiculous conclusion that traffic signals cause more accidents than they prevent.

In the most savage competition we can think of—war—the story is the same. Win, lose, or draw, the cessation of hostilities brings a new, more cooperative relationship between the contesting parties, even if it is only a temporary agreement to avoid trespass. When war does not produce the outright assimilation of a weak country by a strong one, it is sure to bring about new trading agreements, culinary diversity, best friends, and marriage partners. What large "united" country has not been assembled through bloody conflict? Each war sets the rules and the stage for the next. Encouragingly, these rules are becoming more numerous and more sophisticated. Although we have a long way to go, the red tape is a sign that war itself is slowly being regulated out of existence.[533]

Nevertheless, war, being the most extreme form of economic competition, will not be eliminated until the gap between rich and poor is narrowed. Inevitably these inequalities are removed only by conflicts, the nature of which is determined by the consciousness as well as the technology of the combatants. Wars are no longer fought under isolated circumstances. They are now all "world wars" in that the whole world watches the barbarism and experiences the agony. The macrocosmic influences on the combatants take on an evermore-pervasive character. The global demand for an end to lethal competition is itself a cooperative product of that competition.

Socialization

It is almost a commonplace that "no evolutionary future awaits man except in association with other men."[534] The convergence of social microcosms at first produces conflict and then produces larger, more complicated social microcosms. The preparation for existence in the social macrocosm is called *socialization*. This process becomes more and more important for most of us with each passing day, as worldwide pressures for socialization trickle down to us. Thus we must understand socialization to cope with it.

The fundamentals of the subject are not difficult, but they are lost on those who approach it from the systems viewpoint, imbued as it is with the assumption of ***disconnection***. Bronowski once grandly, but erroneously proclaimed that "an animal is either social or solitary. Man alone aspires to be both in one, a social solitary … a unique biological feature."[535]

The social-solitary characteristics of humans are not unique, nor are they only biological. They are common to all microcosms. Being continually in motion, microcosms in one part of the universe are always converging on microcosms in another part, while at the same time diverging from still other microcosms. Hence, it is disingenuous to characterize any microcosm, or any being, as either completely social or completely solitary.

An ant, for example, forages for food as a "solitary" microcosm. As it diverges from the nest, its social relationship with its neighbors diminishes with distance, but the relationship never breaks off entirely. The microcosm of the ant has matter within it encoded to ensure its return. As it converges on the nest, the "social" characteristics of the ant become increasingly evident. The activities that help classify an animal as either social or solitary are purely relative. Bronowski's hypothetical dichotomy serves only to obscure the most important reason for human socialization: the convergence of human beings.

Reactionaries have always viewed human socialization with great trepidation. And as we have seen, it is not unusual for the scientists among them to project this in their work. The McCarthy era disgorged a particularly blatant example involving a Professor H. W. Stunkard who studied social insects, discovering that:

> Loss of freedom, individual bondage, and the evolution of the welfare state are characteristic features of the social insects … At first glance, the colony appears to be a busy, efficient, happy family, with members contributing maximal effort to the welfare of the group. But closer examination of social organization among ants reveals that with the evolution of the "welfare state," there is developed a rigid, rigorous caste system, in which individuals are bound to permanent, monotonous conditions of servitude.[536]

According to Stunkard, progress results from desocialization, a loosening of social bonds, rather than a tightening of them. The simple "lesson" in the "sad plight" of the social insects is that "independence, with freedom … has been the essential condition of progress, whereas the surrender of freedom in an attempt to attain security has led to bondage, regression, and degeneracy."[537]

The reactionary bias against socialization and the begrudging recognition of its power has permeated our culture for millennia as seen in this passage from the first book to see print:

> Behold, they are one people, and they have all one language; and this is what they begin to do: and now nothing will be withholden from them, which they purpose to do. Come, let us go down, and there confound their language, that they may not understand one another's speech. So Jehovah scattered them abroad from thence upon the face of all the earth: and they left off building the city.[538]

Today, we are apt to fear socialization almost as much. Having achieved a modicum of social stability, we avoid breaking the bonds we have and we avoid forming new ones unless it is absolutely necessary. Socialization and desocialization are never easy. It is difficult for the new family in the neighborhood to make friends. Likewise, it is just as difficult for them to give up friends when it is time to leave.

The adolescent boy sitting next to the last empty seat on the school bus is apprehensive when a girl his own age sits beside him for the first time. Nevertheless, after the experience, he is likely to reflect that it really was not so bad after all. Socialization, like any other reaction, is irreversible. That does not mean that people, having moved closer, cannot move away again, but simply that neither action can be repeated in exactly the same way.

People seek no more socialization or desocialization than necessary. It is no surprise that people from rural communities tend to prefer suburban to urban areas, whereas people from urban communities tend to prefer suburban to rural areas.[539] Most prefer environments similar to what they have become accustomed. In the words of geographer P. L. Wagner, "The individual and his environment … although treated as two separate realities for discussion, in fact are one."[540] Wagner also remarks "peoples never merely capitulate to environments. Indomitably, they work to change."[541] This change is not for change's sake but to provide univironmental equilibrium. A person will *always* capitulate to the univironment, since, by definition the univironment includes the person as well as the environment. Faced with a choice between employment in the city or unemployment in the country, the "least stable" individuals do not hesitate, they socialize. Socialization is seldom taken lightly, for it has the potential to destroy the very structure of our lives, which must be rebuilt again. Chardin mistakenly thought that the "struggle for life (is) subordinate in man to the task of cohesion."[542] Instead, we find that the struggle itself is what produces the cohesion.

The Rise of Civilization

It's obvious: socialization produces civilization. But as Hardin[543] pointed out, there are three fundamentally different views of the evolution of civilization:

1. The Golden Age Concept: Things were once wonderful but look at the mess we're in now.
2. The Cyclic Theory of History: Things are always getting either better or worse, but there's never any real change or genuine direction to history.
3. The Idea of Progress: There is a progressive improvement in human life.

The Golden Age Concept

The Golden Age Concept, like most theories, has some validity when applied to certain portions of the universe at certain times. All microcosms come into existence through convergence and go out of existence through divergence. For every birth there eventually must be a death. As this sinks into our consciousness, the Golden Age Concept becomes a personal reality. Aging reactionaries, their bodies failing, their minds blessed with optimistic memories and plagued by pessimistic outlooks, naturally complain of the destruction in their corner of the universe. Whole societies sponsor heroic myths about the glories that once were. From the Garden of Eden to the Big Bang, the promoters of the Golden Age Concept express their sense of ongoing destruction while ignoring the ongoing construction.

The Cyclic Theory of History

The Cyclic Theory of History was a more generalized and more balanced concept than the Golden Age Theory. It drew on the analogy with birth as well as death. Accordingly, civilizations were said to come into being and go out of existence in endless succession. Through the back door, the Cyclic Theory supported the reactionary's dream by foretelling an eventual return to the good old days of decreased socialization. These longings for a second chance and the pleasures of the past appear in popular myths ranging from Salvation to the Pulsating Universe Theory.

The Cyclic Theory, of course, rests on the indeterministic assumptions of finite causality and ***reversibility***, the belief that whatever happened once can happen *exactly* the same way again. As I have explained before, *causality* and *irreversibility* assume this to be impossible, while *relativism* shows why it is impossible: no two things and no two events in the universe ever could be *identical.* They might be similar, but they cannot be identical because all microcosms are in constant motion relative to all other microcosms. In an infinite universe, the relation between any microcosm and the macrocosm is a unique, onetime affair.

At bottom, the Cyclic Theory failed to accomplish its mission, which was to explain why things happen. To do this, it was necessary to discover a direction for the reactions that produced history. When an overall direction was found, the Cyclic Theory became obsolete.

Nevertheless, the Cyclic Theory did express a gut feeling about how things might go. Didn't individual civilizations "rise" and "fall"? And wasn't there a chance that civilization per se might rise and fall too? The greatest failure of the theory was in its explanation of why civilizations declined. This was compounded when the explanation was generalized to civilization as a whole. The indeterminists who pushed the theory usually claimed that declines resulted from microcosmic causes, which they saw mostly in moral terms. Instead of science, they tended to purvey the lessons of Sodom and Gomorrah. To this day, the person on the street still tends to believe that "orgies and decadence drove ancient civilization to collapse."[544]

From their vaunted position in the modern age, more scholarly indeterminists blame the fall of Greek civilization on the now-detested institution of slavery.[545] For these folks, too, "moral degeneracy" still threatens the whole of human civilization. According to a spokesman, "Our troubles are not fundamentally political; they are ethical, metaphysical, and ultimately theological."[546]

Univironmental Determinism rejects such nonsense because it views civilization as a microcosm whose expansion or contraction is dependent on the macrocosm as well as the microcosm. If socialization produces the rise of a civilization, desocialization destroys it. But if one considers the proper microcosm, human civilization has not yet fallen. True, magnificent civilizations built in semi-isolation have been destroyed after that isolation was broken. The interpersonal and governmental relationships characteristic of those relatively dense populations were largely destroyed when their populations dispersed. Also true, however, is the observation that the dense population that comprises civilization in one geographical area, if forced to leave, will automatically develop a semblance of civilization wherever it goes.

Obviously, there can be no relations between humans if the humans themselves do not exist. Changes in population density, like changes in concentration within other physicochemical systems, are the primary influence in the development or destruction of structural bonds. The initial convergence, the increase in population that produces a particular microcosm, leads first to conflict, and then to cooperation, socialization, and civilization. The microcosm of civilization cannot "fall," "decline," "dissolve," or "disintegrate" unless the relations between the social microcosm and the macrocosm change first.

Population density, then, is central to an understanding of the historical rise of civilization.[547] Indeterminists, in the habit of viewing population pressure as secondary instead of primary,[548] tend to obscure the main driving force of civilization in a maze of peripheral arguments. But from a global perspective, it so far has been mostly the *quantitative* changes that have forced *qualitative* changes in society and not the other way around. Once population densities become relatively constant, the qualitative changes come to the fore.

No civilization has fallen without a decline in population. Emigration is as much a threat to a civilization as starvation or mass slaughter. Imagine what would happen to any modern city if, for example, millions of acres of fertile, virgin land became available nearby at no cost. As in the Oklahoma land rush, the sound of the gun would set off an exodus sure to decimate the city. Arnold Toynbee's followers would gaze upon the ruins, shake their heads, mumble something about moral degeneration, and return to their desks to write once again of the "fall" of civilization.

But if we should abandon the microcosmic analysis perpetrated by the Cyclic Theory, we would see that an inclusion of the new homelands invariably reveals no decline in civilization at all. This is not to say that the new, dispersed forms of civilization are equally "civil" or equally organized, but that the new lands, previously unoccupied, now have *people*. They have a rudimentary form of civilization that did not exist there before. Given a static population, the hinterlands can be civilized only at the expense of the cities, and vice versa. When we travel to the country, we automatically socialize the country and desocialize the city; when we travel to the city, we automatically socialize the city and desocialize the country.

The rise and fall of civilizations must be viewed through population shifts. Thus, the *addition* of slaves to Greek society resulted in an actual *increase* in civilization in spite of what we now think of that institution. Of course, the commerce in slaves was an activity that eventually helped to break the semi-isolation required for Greek civilization to develop in the first place. Mariners who sought slaves and treasures for the mother country sometimes did not come back. At other times they reported discoveries of new lands of "milk and honey" where the living was easy. Each retelling fostered emigration and damage to the civilization not unlike that of the arrows from raiding war parties.

Much is made of the civilizing of the New World through immigration. In the United States, a nation of immigrants, we tend to neglect the other side of the coin—the corresponding declines in civilization in the mother countries. Each wave of migration from Europe was preceded by convergences attended by great social and economic conflict. The advent of cheap oceanic travel for the masses presented people with a choice: socialize or leave. As a consequence, social movements in Europe were devastated.

The German example is instructive. A rapidly increasing population and an archaic economic system combined to produce the conditions leading to the failed revolution of 1848. Large numbers of Germany's persecuted revolutionaries and half-starved rejects fled the country. Those left behind had to make do with a feudalistic government for nearly a century thereafter.

Put as simply as possible, the evolution of advanced social microcosms in the mother countries was temporarily "reversed" by a loss of matter—human microcosms. As mentioned before, all microcosms become less ordered or less "organized" whenever matter leaves them. Within social microcosms, those people with high-level skills are often the first to leave. The administrators of social microcosms correctly view losses to emigration, particularly of those people in which the society has a heavy financial investment, as a great problem. What school principal doesn't fret when enrollments decline? What night stroller fails to note that when a section of the city becomes depopulated, it becomes less civilized?

In the distant past, the administrators of social microcosms often counted on geographic features to prevent emigration. Later, they built walls or curtains of brick, iron, bamboo, or red tape. The univironmental boundaries of microcosms act in two ways: they tend to keep the macrocosm out and the submicrocosms in. It is true that, at times, governments encourage emigration to defuse domestic conflict and to thwart the expansion of social classes antagonistic to them. But these policies inevitably are reversed as soon as the internal conflict lessens and the danger of foreign conflict increases. The social microcosm that loses its constituents is involuntarily weakened and less able to defend its borders against the macrocosm—other social microcosms. Ironically, immigrants or their descendants sometimes return with a vengeance as extensions of freshly strengthened social microcosms that expand against the mother country in war or other forms of competition. The German-Americans of World Wars I and II are an excellent example.

Political boundaries typify the sieve-like qualities of all univironmental boundaries. Countries absorb matter and motion and they emit matter and motion in response to changes in the univironment. The geographic boundaries of one country can expand only at the expense of another. Shifts in political boundaries occur only when inequalities exist. Political boundaries have less and less meaning as countries become less isolated and more alike.

The Idea of Progress

The Idea of Progress, along with the idea of evolution, could only occur when rapid changes became especially evident—during the Industrial Revolution. As mechanization developed and people's lives were manifestly changed, it became more and more obvious that there was no turning back. To be sure, the momentum of industrialization occasionally suffered setbacks, but it always recovered stronger than ever. To those with their eyes open, a direction to history was unmistakable.

The Golden Age Concept and the Cyclic Theory of History were useless to the leaders of industrialization. A sure way to lose the leadership was to take those theories seriously. The war cry of the industrialist was, "Ever upward, ever onward!" Industrial expansion seemed limitless. Thus it was right and proper that, during its most explosive phase, new myths should be invented to complement such a grand vision. Even cosmologists obliged with their Theory of the Expanding Universe, although few of them would agree that this was anything more than coincidental.

Another remarkable "coincidence" also attended the Industrial Revolution: the spectacular quantitative expansion of the Social Microcosm. Indeterminists and their propagandists in the already developed countries were aghast. What would we do with so many souls? With so many being born into abject poverty, surely the planet was headed for disaster.

Population Growth and the Industrial Revolution

For decades it has been fashionable for indeterminists to view human population growth as "out of control," as a bomb about to explode.[549] The fear of "overpopulation" is the logical conclusion of the free-will argument taken on the grand scale. The other end of that bargain, however, sees the eventual demise of those fears as particularly damaging to the case for free will. Indeterminists worry because they view birth control as a matter of "free" choice. Unlike other animals, human populations supposedly are not regulated in an orderly way. It is only by "chance" that you or I have so many children and no more. In the manner of Chardin's anarchy theory of life, the Social Microcosm supposedly has nothing within it that could respond to the without. The human spirit roams free and loose over the surface of the planet.

What the doomsayers of "overpopulation" forgot is that the Social Microcosm *does* respond to the macrocosm. They are themselves a considerable part of that response. They may not be theoretically conscious of their historical role in the birth control movement, but their actions still have an effect. To those planning to have large families, the words of an indeterminist can sting as much as those of a determinist.

For determinists, population growth and population control are natural. As with all other microcosms, the Social Microcosm can grow only at the expense of the macrocosm. The macrocosm, though infinite, does not contain an infinite quantity of the special types of *nearby* matter and motion necessary for infinite expansion. It cannot sustain the growth of any particular type of microcosm for an infinite duration. The Social Microcosm continually moves toward univironmental equilibrium. The more it expands, the less it can expand in the future. When the global population increases exponentially, as it did until 1989, it is only because it is univironmentally possible.

Along with rapid population growth came explanations for how it might be curbed. Neo-Malthusians resurrected the idea that a single factor, food production, will limit the population of the human species and that it will do so only through mass starvation.[550] Indeterminists promoting this idea forgot the most important lesson we have learned since Thomas Malthus: rapid population growth does not begin until the industrializing stage of evolution begins, and does not end until that stage is completed. The outlines of this were first dimly apparent in Europe. As each country entered the early stages of industrialization, the rate of population growth increased; in the later stages the rate decreased. The combined result is known as a *demographic transition*. Today, the developed countries have the highest population densities and the lowest rates of growth, while developing countries have the lowest densities and the highest rates of growth.

The connection between industrializing and population growth was blurred because industrial expansion never occurred in isolation. As the process neared completion in one country, it jumped to another. Links were established with lesser-developed countries via colonialism, neocolonialism, hegemonism, and other forms of imperialism. The developed countries grew by formal or informal annexation; the boundaries of the resulting economic microcosms enveloped the newly developing territories. The resources of undeveloped countries became de facto properties of the developed countries, enabling both to increase in population. This tendency for capital as well as people to emigrate from one semi-isolated microcosm to another made demographic transitions and their relation to the Industrial Revolution appear indefinite. The final test of the connection between industrializing and population growth required a greater degree of isolation. The only microcosm suitable for this was the earth itself.

Then it happened. For the first time in the history of *Homo sapiens*, signs of a global demographic transition began appearing. First there was a slowdown in the rate of population growth expressed as a percentage of the existing population (Fig. 12-1). According to the U.S. Bureau of the Census,[551] this reached a maximum of 2.2 percent in 1963. It has declined ever since, with the 2002 rate estimated at only 1.2 percent. Still, for a generation thereafter, the number of people added each year continued to increase until it reached its maximum in 1989—88 million/year (Fig. 12-2). This too has declined ever since, with the 2002 estimate being less than 75 million/year. The 1989 maximum marks the Inflection Point for humanity's growth. An *inflection point* occurs when the change in the rate of change switches from an increase to a decrease (or vise versa). As in the titration of an acid with a base (Fig. 10-1) a perfect sigmoidal curve is centered about the inflection point, which occurs halfway through the process being described. If humanity's growth followed such a process, as it shows every likelihood of doing, then the sigmoidal curve for it would be like the one in Fig. 12-3. From this we predict that the "carrying capacity" of the earth is twice whatever the population was in 1989—5 billion X 2 = 10 billion. Each year will see additional declines in the rate of population growth although absolute growth will continue to be dramatic over the next half century and will likely continue for another two millennia.

Prior to the Inflection Point, it was anybody's guess as to what the maximum population of the earth would be. Early in the global demographic transition, straight-line projections were always too low; nearer the Inflection Point they were always too high. Demographers have slowly backed away from their embarrassing pre-1962 estimates. Paul Ehrlich and other neo-Malthusians have been totally discredited. The "population bomb" has become a "population bust."

Population forecasting, it seems, is as difficult as weather forecasting and as politically motivated as economic forecasting. At the local level, governments scramble to count every passerby, the better to get their share of revenue from the next highest jurisdiction. At the academic level, distinguished professors search for every shred of evidence that would continue to support their previously published gloom and doom predictions of overpopulation and mass starvation. And as one might imagine, census data for countries with high growth rates usually are badly out of date by the time they can be used in a global census. To get an idea of the actual population existing at any time following an official census, demographers must extrapolate.

This tends to produce population estimates that are too low during the first part of a country's demographic transition and too high during the last part. There is little reason to believe that this will not be the case for the global demographic transition. For the next few decades, at least, population figures must be viewed with a jaundiced eye. The United Nations wisely publishes its statistics with the caveat that "unless otherwise specified all figures are estimates of the order of magnitude and are subject to a substantial margin of error."[552]

How the many variables should be controlled or discounted are matters of census design and widely varying assumptions. The problems, of course, are magnified with respect to the global census. In this, the projected theoretical shape of the growth curve is instructive. No one knows what the eventual shape of this curve will be for the Social Microcosm, but demographers who appreciate its overwhelming significance tend to favor growth forms that are relatively symmetrical about the Inflection Point.

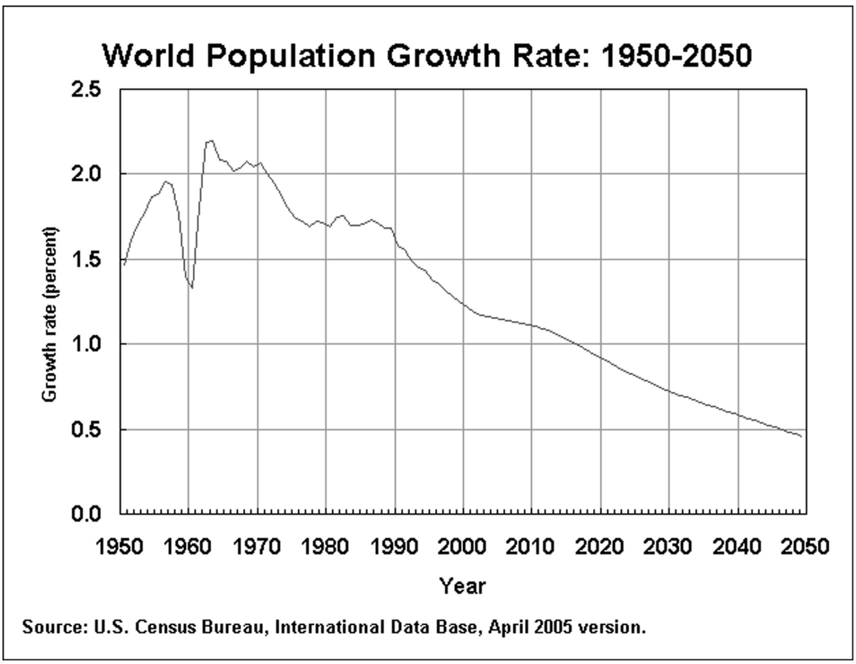


Fig. 12-1. Global population increase as a percent of the population according to the U.S. Census Bureau.[553] The maximum was 2.2 percent in 1963. It is now half that.

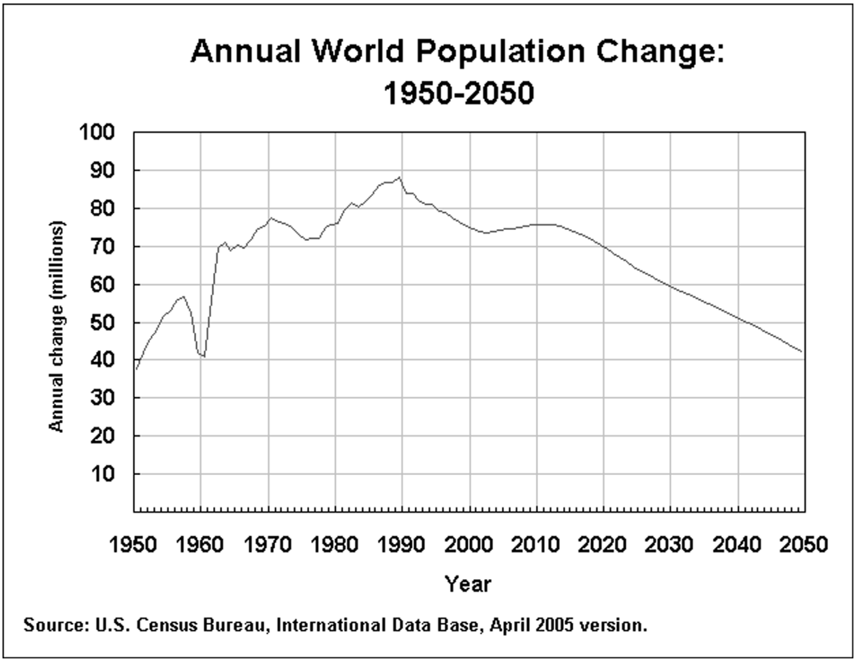


Fig. 12-2. Global population change showing that the maximum, 88 million, occurred in 1989.[554] It is now less than 75 million. Note that the niche opened by the losses suffered during the 1958–61 famine was quickly filled during the subsequent decade.

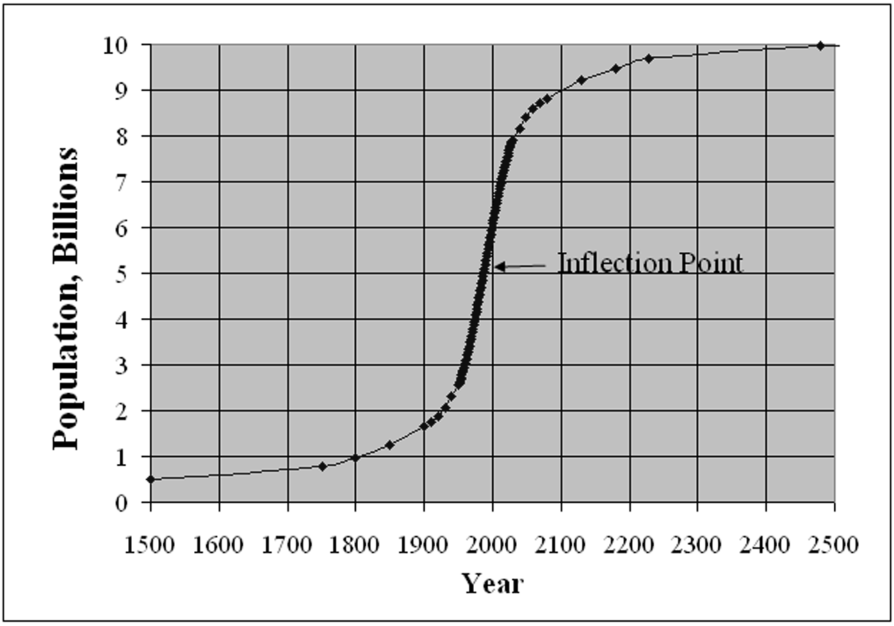


Fig. 12-3. Sigmoidal growth curve for global population assuming perfect symmetry about the 1989 Inflection Point. Sources: Historical estimates and 1950–1989 data from the U.S. Census Bureau.[555]

It is now clear that the quantitative evolution of the Social Microcosm is not linear, but instead is similar to that of other microcosms capable of reciprocal interaction with the macrocosm (compare Figs. 10-2 and 12-3). This whole idea that our species is no exception to the finely tuned regulation produced by its own environment is the supreme challenge to indeterminism. Where is the "free will?" Can't we have as many children as we want? Could it be that we "want" as many as we have? Each passing census demonstrates the inevitable evolution of the Social Microcosm. Barring a catastrophic change in the macrocosm, no amount of "free will" can return us to exponential population growth.

Some interesting predictions now are possible. It has long been obvious that economic expansion both stimulates and requires population growth. A doubling in food production, for instance, makes no sense unless there is a doubling in food consumption—a near impossibility without also doubling the number of people (or doubling their appetites). Thus, as the population in market economies increased by 51 percent between 1958 and 1978, primary commodity production (food, fiber, timber, minerals, and other raw materials) increased by a similar amount: 60 percent.[556] The production of manufactured goods, however, increased by a whopping 176 percent during those two decades. If there is a 1:1 relationship between increases in population and food production, then the relationship with industrial production is even more pronounced.

Although it is logical that an unchanging population would not require annual increases in food production, it is not quite as obvious that this should be true of industrial production. *On an individual basis*, of course, developed countries have managed to sustain large increases in industrial output without themselves undergoing correspondingly large population increases. But they have not done so in isolation. Without markets for surplus manufactured goods, production in the industrial economies tends to stagnate, as it did during the Great Depression of the '30s, and as it does during every recession.

After World War II, economic links between the industrial economies and the developing economies became increasingly intensified. From 1938 to 1958 the production of manufactured goods in the market economies increased at an annual rate of 4.6 percent.[557] Then, in 1958 (thirty-one years before the Inflection Point), the rate of increase shifted to 5.2 percent as global populations exploded. Uniformitarians who believe in the association between population growth and economic growth might argue that, in 2020 (thirty-one years after the Inflection Point), the production of manufactured goods will return to the 4.6 percent growth rate for another two decades.

The prospect for continued economic expansion is still a matter of intense debate among economists even though it is rather easy to show that annual increases in industrial output, like annual increases in population, cannot be sustained indefinitely.[558] No matter what growth rates are achieved in the interim, neither population nor production will expand forever. As I will show in more detail in the next section, the high rates of economic expansion experienced during the last two centuries may be characteristics of the industrializing process, but they are not necessarily characteristics of industrial society per se. At some distant point in the future, annual changes in both population and production will be as insignificant as they were a thousand years ago. Let us assume for now that an ideal 1:1 relationship exists between population growth and economic growth. Then we can use our projected growth form (Fig. 12-3) for some interesting speculations about the progress of global economic development.

According to Phyllis Deane[559] the first industrial revolution occurred in England in the hundred years between 1750 and 1850. Taking 1750 also as the starting point of the global phenomenon, and assuming symmetry about the Inflection Point, both the Industrial Revolution and its interdependent population growth should draw to a close by the year 2228. Of more immediate concern to our own generation is that the most significant portion of the global industrial revolution likewise will span a mere century. During the hundred years between 1939 and 2039, global population will increase from 2.3 billion to 8.2 billion (Fig. 12-3). This will require and stimulate an allied economic expansion—an annual growth rate of at least 1.53 percent. During this period all fundamental human needs must be supplied at this minimum rate just to keep pace. Growth in population requires growth in almost everything else. At minimum, the production of food, shelter, and housing must grow at the 1.53 percent rate. So we have lived in a necessarily growth-oriented society during a unique, unprecedented period for the human microcosm.

But a cursory glance at Fig. 12-3 gives an inkling of what eventually will happen. The global economic expansion that raged before 1989 is now slowly coming to an end. As the quantitative expansion of the Social Microcosm begins to slow, new demands will be placed on it—political demands.

The Political Imperative

The economic expansion will not continue indefinitely because it is becoming unnecessary as well as impossible. It will become more and more difficult for developers to find resources and people that are not already part of the industrial system. The urban infrastructure, once built, need not be rebuilt. The building of the interstate highway system in the United States, for example, will not be repeated. The highway system, like so many other parts of industrial civilization, need not be built twice. Its simple maintenance provides little opportunity for growth.

Global economic development really amounts to global urbanization, an irreversible process that is now about half complete. As the industrializing-urbanizing stage of evolution draws to a close, the great construction binge we have enjoyed during the last few decades also will begin to wane. Large annual increases in production will become less and less urgent and the day will come when the production of manufactured goods will no longer produce the urban lifestyle—it will merely reproduce it. At that point we will have reached a steady state economy with a political system suited to the task.

The Industrial Revolution has produced a vast global migration from individualistic, rural existence to collectivistic, urban existence. Political, social, and economic relationships suited only to rural life or to the high growth rates of the transition period will not survive the period of declining economic growth. The Social Revolution is developing hand in hand with the Industrial Revolution. This is readily apparent with the formation of each new social agglomeration.

Under free-market capitalism, competition within each market sector inevitably produces an overabundance of products and resulting declines in market prices. The winners of this competition survive low prices by exploiting economies of scale in production and distribution. The losers and their paraphernalia are either discarded as obsolete or acquired by the winners to form still larger entities still more capable of withstanding the pressures of declining prices and reduced rates of growth.

Each merger is part of an evolutionary process as irreversible as the Industrial Revolution itself. No amount of "free will" can reverse this tendency. The demise of small family farms and corner groceries continues apace no matter how much we deplore it. In a world filled with over 6 billion people, even niche markets are transformed from mom and pop operations serving a few hundred to multinational conglomerates serving millions. Why, even the simple brewing and selling of coffee has become an international social enterprise. In 2006, Starbucks, for example, had over 11,000 stores, with forty-nine in Beijing alone. For many products, the global mass market now allows the cost of production to be measured in pennies instead of dollars. By the time the Industrial Revolution is over, independent production will be obsolete for all but the most trivial items. The cost of independent production would be prohibitive.

So why the Industrial Revolution? The Industrial Revolution occurred and is occurring despite there being innumerable people opposed to almost all aspects of it every step of the way. So far, hundreds of millions suffered and millions died as the "invisible hand of capital" transformed the planet. The lamentations are well documented in a multitude of pacifist and socialist texts. What did we, as the social microcosm, do to deserve this?

Actually, it is not what we did, but what we did not do. The social microcosm, like all microcosms, is governed by the principle of least effort. It cannot and will not do more or less than its univironment will allow. It so happens that synergism occurs whenever people get together, with the result being greater than the sum of its parts. Note that there was no abrupt change in global population when the Industrial Revolution officially began in England in 1750 (Fig. 12-3). This means that the faceless process behind the revolution was present from the beginning. It was there when two people moved the first large boulder after one had failed. It was there when a group of hunters killed the first large and dangerous game that a lone hunter could not.

Synergism, then, can generate overall increases in production with overall decreases in effort. Not all attempts at synergism succeed, however. This leads to the eternal question that underlies all our activities and all our politics: *should we do it together or should we do it apart?* In any particular instance the answer to the question often is not immediately obvious. The univironment keeps changing. What is done individually one day might be done collectively the next day, and *vice versa*. Each attempt at socialization or desocialization amounts to an experiment. Neither the left nor the right can know the outcome with certainty. But one thing is clear: an increase in population density always results in an increase in socialization. It is no accident that the godless denizens of the left abide in dense urban areas, while the pious conservators of the right roam the wide-open spaces. Now, as global populations become ever more dense and the environment becomes ever more limiting, which political direction do you suppose will become ever more dominant?

Univironmental Determinism and the Social Microcosm

Social microcosms move in relation to the main features of their respective macrocosms, their motions being determined by the univironment—the within and the without. Like all microcosms, social microcosms collide as they "compete" for identical spatial positions. Like all microcosms, social microcosms exchange matter and motion; one expands while the other contracts, and one speeds up while the other slows down. The clashes are not simply mechanical and systemic, but neomechanical and univironmental. Each of the colliding microcosms is irreversibly changed in the process of colliding. Formerly conflicting social microcosms form new social bonds necessary for larger, more complex microcosms.

Even the largest microcosms must contend with other microcosms. The macrocosm is continually converging on the univironmental boundaries of the social microcosm, just as the social microcosm converges on it. Like all microcosms, social microcosms expand to fill the available space. There will be no return to the biopoetic ooze. Despite all the indeterministic naysayers, the rise of civilization, industrialization, urbanization, and socialization is progressive—an irreversible process.

We are privileged to live at a time when the Social Microcosm is undergoing its most rapid evolution. With the advent of the global demographic transition we have, as a species, surpassed the halfway mark in our juvenile development. Like all good teenagers, the Social Microcosm must learn to live within its means. It must substitute qualitative growth for quantitative growth, wisdom for naïveté, generosity for avarice, and determinism for indeterminism. During the next few decades humanity will continue to experience an inordinate share of growing pains, but the best is yet to come.

Part Five

The Conclusions

Chapter 13

The Myth of Exceptionalism

> But we have assumed that at a certain point in the distant past man became man and evolution stopped.[560]

By now you have developed a fair idea of the scientific answer to Thomas Huxley's "question of questions" posed on the first page of this book. What is our place in nature? As microcosms, portions of the universe, we act on the macrocosm and it acts on us. As a Darwinist and an agnostic, Huxley was unable to appreciate how all encompassing this interaction really was. No evolutionary mechanism short of Univironmental Determinism could provide the proper framework for answering that question. From the most primitive reduction to the most complex expansion, our answer henceforth must consciously avoid both the macrocosmic mistakes of nineteenth century mechanism and the microcosmic mistakes of twentieth century systems philosophy.

Unfortunately for indeterminists, there is a Faustian bargain required of anyone seeking a unified, scientific worldview. It is not enough merely to translate *Weltanschauung* as one word. We must also rid ourselves of an affliction that permeates nearly every answer ever proposed to the question about our place in the universe: the "Myth of Exceptionalism." *Exceptionalism* is the notion that humanity, although perhaps once subject to evolution, is no longer completely subject. The prevalence of this view, of course, is the main reason a universal mechanism of evolution has gone unrecognized for so long. The acceptance of Univironmental

Determinism as that mechanism is contingent on the rejection of exceptionalism. Univironmental Determinism simply states that *everything* that exists has arisen through evolution; that *every* process is evolutionary. Just because we, the Social Microcosm, have consciousness, and thereby appear to be a favored species, does not mean that we could exist without interacting fully with the rest of the universe or that we could do things contrary to the laws of nature.[561]

Scientists always had a vision of the orderliness of the universe. The vision has dimmed with the onslaught of indeterminism early in the twentieth century, but it will return with a new way of thinking: univironmental thinking. The assumptions underlying Univironmental Determinism both build on and destroy assumptions implicit in the current way in which we do science. As I have tried to show throughout the book, the shift in emphasis from the current paradigm, systems philosophy, to the one I propose, Univironmental Determinism, requires a wholesale reinterpretation of major theories linked to the presently accepted cosmological model. I have given only an outline of what must be done to refute the Big Bang Theory and the philosophy on which it is based. The overall picture began with determinism, the belief that all effects have causes, and it must end with determinism. The defeat of exceptionalism is one of the last steps in this program. That will not be easy, judging by the preponderance of comment in its favor.

The Myth of Exceptionalism in Popular Scientific Literature

Open almost any textbook or popular work on the implications of science for humanity and you will find examples of exceptionalism in profusion. At the least, these statements are mere hand wringing: "Man's future is in his own less than competent hands;"[562] "at the moment … man lacks … the control … necessary for survival;"[563] "the world is not working well."[564]

At the most, they promise or boast of impossibilities: "perhaps someday (humans) can control the environment absolutely;"[565] "life could evolve sufficiently to overwhelm matter;"[566] "man, now master of his own fate;"[567] "it may be that … the human mind will become the master of matter;"[568] "until man appeared, evolution rested on the interplay of random change;"[569] "(man) must be in control of his own evolution. (Man is) the only one capable of controlling it, and this control must include the power to slow down and stop evolution."[570]

And lest anyone get the impression that such slips of the tongue emanate only from the bourgeoisie, let us not forget this contribution from Frederick Engels himself: "Man, at last the master of his own form of social organization, becomes at the same time the lord over nature, his own master—free."[571]

The peddlers of exceptionalism tend to portray humans as either stumbling, blithering idiots or as magical beings capable of rising above matter and becoming the all-powerful gods of their dreams. Of course, neither the pessimistic nor the optimistic view can be scientific—neither reflects reality. The one great error characteristic of all such pronouncements is that, although they attempt to address univironmental issues, they are all spoken from a microcosmic point of view. Their perspective is simply too narrow for the task they are asked to do.

As shown in the previous chapter, the Social Microcosm—humanity—is part of a univironment. It has no more possibility of assuming complete control of itself than does any other microcosm. The Social Microcosm will continue to evolve at the behest of matter in motion within and without. Univironmental Determinism makes no exceptions.

There is a particularly detestable way of describing humanity's place in nature. It pretends a trendy deference to the univironmental idea—"this whole, the universal as well as the social, is a new kind of whole"—and then blows it all through a contradiction in the same sentence: "determined not from outside but from within."[572] It bows to determinism on the one hand—"Nothing is isolated"—and then bows to indeterminism on the other: "systems create themselves."[573] But as I have maintained all along, the motions of systems—microcosms—are *not* determined only from within; systems do *not* create themselves. It is a travesty of the scientific method to assert the unity of the universe, and then, in the same breath, assert what amounts to its opposite: an absolute ***disconnection*** in its evolution.

In philosophy and science, the question of exceptionalism is the bottom line. These declarations from the popular scientific literature are important because they are both a measure of the public understanding of science and the cultural pressures that bear upon scientists. One must assume that statements voicing exceptionalism are thought to be true by those who read them as well as by those who disseminate them. Because popular science abstracts from established science, we must conclude that, philosophically, professional science is not much better off. The microcosm of science generally is expected to lead the macrocosm of the culture, but like all leadership, it seldom gets too far out in front.

Exceptionalism and Dialectical Materialism

Although many of the Ten Assumptions of Science were implicit in their philosophy, Marx and Engels were not explicit determinists. They were extremely critical of classical mechanism, and no more generous toward the isolationism that presaged formal systems philosophy. Nevertheless, on the question of exceptionalism, Marx and Engels were ambivalent. In the macrocosmic, classical mold, Marx claimed that the material conditions of life determined consciousness and that consciousness did not determine material conditions. In the microcosmic pattern of modern systems philosophy, Engels joined the anthropocentrists in asserting an absolute animal/human dichotomy; "animals also produce, but their productive effect on surrounding nature, in relation to nature, amounts to nothing at all. Man alone has succeeded in impressing his stamp on nature."[574]

The strong hints of univironmental thinking elsewhere in his scientific writings were undermined, as Engels waxed strong on the helplessness of animals:

> This history, however, is made for them, and in so far as they themselves take part in it, this occurs without their knowledge and desire. On the other hand, the more that human beings become removed from animals in the narrower sense of the word, the more they make their history themselves, consciously, the less becomes the influence of unforeseen effects and uncontrolled forces on this history, and the more accurately does the historical result correspond to the aim laid down in advance.[575]

But as I have argued all along, there are no "uncontrolled forces." Each thing is controlled by other things. Unforeseen events can be considered uncontrolled only in the subjective, microcosmic sense promoted from Copenhagen. Because the univironment is infinite, it always has an *infinity* of unforeseen or so-called "uncontrolled forces" to which the Social Microcosm is always subject. Like all other microcosms, the Social Microcosm has a purely reciprocal relationship with the macrocosm.

At first glance, it may *appear* as though the Social Microcosm has the power to gather more and more of the macrocosm unto itself, thereby placing the macrocosm under its absolute command. But this is little more than the delusion of the person who reduces the action of the vacuum cleaner to that of the motor and forgets about the air molecules also necessary for its operation. As submicrocosms within the Social Microcosm, it may appear to us as though all the action is internal, but this too is a pre-Copernican illusion. It is a mistake to hypothesize some unique evolutionary development within the Social Microcosm that gives it any more autonomy than any other microcosm.

Few followers of Marx and Engels have rushed to correct the indeterministic mistakes of the masters regarding exceptionalism. Leon Trotsky, for instance, did them one better by lapsing into a microcosmic rhapsody: "Through the machine, man in Socialist society will command nature in its entirety."[576] Perhaps out of their indeterministic fears of debasement, the dialectical materialists of the USSR Academy of Science supported this official version of exceptionalism: "The development of society is subject not to biological laws but to higher social laws. Attempts to spread to humanity the laws of the animal kingdom are attempts to lower the human being to the level of beasts."[577]

By such logic, nothing learned about animals or about biology could have any application to studies of humanity. *Relativism* be dammed! Biology and culture should be two *absolutely* unconnected things, said those otherwise known for their belief in *interconnection*.

Controlling the Social Microcosm: The Exceptionalism Paradox

Perhaps the USSR Academy of Science would have agreed with John Heller, who proposed the grand finale of exceptionalism: "The logical climax of evolution can be said to have occurred when, as is now imminent, a sentient species deliberately and directly assumes control of its own evolution."[578]

And what about this matter of control? If the Social Microcosm is to be "self controlling," how is this to come about in the physical sense? How does an entire species get a grip on itself? How can the Social Microcosm ascend into the driver's seat of the "chariot of evolution"?[579]

Surely the consensus necessary for this magnificent feat will involve a new kind of politics. But, according to Ferkiss, we need not dismay the attainment of such an ideal state. "Existing political systems make such fears groundless. The political and governmental structures even in the most technologically advanced nations render man bewildered and impotent, a prisoner of his most primitive atavism and the plaything of the fates."[580]

To attain the state of amazing grace, the indeterminist asks us first to accept the Sartrean burden. Then, and only then, would he allow political power to become egalitarian; "The diffusion of power runs the risk of becoming a dissipation of responsibility as well unless each participant constantly holds himself responsible not only for the immediate result of his particular acts but also for their ultimate impact upon the shaping of the whole."[581]

In other words, the Social Microcosm will assume control of its own evolution on the day the world has pure democracy, free will, and the ability to make perfect predictions. Because none of this is really possible, the indeterminists proposing it need not worry about losing political power, at least not to those who agree to such terms.

The above is typical of what I call the *exceptionalism paradox*—the dilemma facing anyone who asserts the supremacy of humanity over nature. Its only resolution is a firm belief in Univironmental Determinism, which means that the evolution and therefore the control of the Social Microcosm is a result of the reciprocal interaction of the Social Microcosm and its macrocosm.

Garrett Hardin is one indeterminist who has thought all the way through the paradox. He starts out by correctly observing that "man's future development might also be a *natural* one. … Until proof to the contrary is forthcoming, the evolutionist must assume that man is a part of nature. The biologist sees no end-state for man and his society which must continue evolving until the day of extinction."[582] And then he begins to waffle: "Man, the slender reed that thinks, can alter the force and direction of natural forces somewhat, but only within limits."[583]

Like the old laissez faire economist, he says that "The wisdom of so doing is at least questionable."[584] Hardin's quandary deepens as he asks, "How is man to control his own evolution? How can he possibly have the wisdom to do so? How can the animal-that-makes-himself conceive the best possible image to mold himself into? We see no answer to this problem."[585]

His frustration grows: "The worst of it is, we have forced ourselves into a position in which we *have* to give an answer."[586]

Isn't it ironic that the importance of the question diminishes as the answer becomes clearer? For Hardin, as for other indeterminists, the question remains important and forever unanswerable. Only by becoming determinists can they be rid of the exceptionalism paradox.

Species Suicide

One logical outcome of exceptionalism is the possibility that humanity might cause its own extinction.[587] Pessimistic indeterminists have a field day with this one, especially now that it is possible to calculate the effects of such an attempt in megadeaths. Typical is Wagner's comment that "a fair chance now exists for man to bring about his own extinction and the ruin of the world."[588]

Carl Sagan said, "There is a serious question whether … a global self-identification of mankind can be achieved before we destroy ourselves with the technological forces our intelligence has unleashed."[589]

Doomsayers van der Veer and Moerman stand helpless against their own neovitalism: "If our self-destructive urge springs from within man himself we can still hope that something may be done before darkness overtakes intelligent life on earth!"[590]

This view, along with the nuclear weapons on which it is predicated, is the most terrible product to come out of systems philosophy. Each day, perhaps millions of people anguish needlessly over what, from the univironmental point of view, is surely an impossibility. Not only is this a prime example of microcosmic, unscientific thinking, there is absolutely no factual evidence to support it. No one has yet discovered a single verifiable case of species suicide: an instance in which an entire species became extinct by its own hand (or paw). Of course, indeterminists can point out that *Homo sapiens* is different and that the entire exceptionalism argument says otherwise. They can point out that individual humans, as well as other animals, commit suicide, and thus it is possible that the conglomeration of all humans might do it too.

But this fancy bit of indeterministic reduction doesn't wash. The key error is that it uses the common neovitalistic interpretation of suicide as a microcosmic instead of a univironmental phenomenon. When suicides say "Goodbye, cruel world!" or "For God and country!" they express this necessary connection between microcosm and macrocosm. Suicide may appear to be a solitary act, but it is clearly a social act. Whenever a suicide occurs, the macrocosmic factors are pervasive. Competitive pressures are sometimes so great that "self-destruction" seems preferable to continued stress. Always, there is another member of the same or another species competing to fill the niche to be left by a suicide. Indeed, one especially pernicious way of competing has been to convince others, directly or indirectly, that suicide is a viable or even honorable alternative. But the entire human race would never choose such an option. Humans may choose it for another species or even for another group within their own species, but they will not choose it for themselves.

To be sure, it is not altogether impossible that the horror of horrors might occur. But nuclear war, when and if it happens, will be a result of an enormous clash of social microcosms and not of some mysterious self-destructive urge of the species. Most of humanity might be wiped out in minutes, and many of the rest might expire over time due to the effects of radiation. But even this deplorable tragedy would not be occasion for human extinction, because, as mentioned before, extinction is a univironmental reaction. When the glorious-inglorious reign of humanity comes to an end, the final command will be given by the macrocosm. The Social Microcosm will go the way of all microcosms, but like all the others, it won't be exclusively at its own hand.

The reality of the nuclear threat is far worse than the ideality of species suicide. What difference could it possibly make to those of us who, living in the largest cities in the world, are sure to be destroyed in a nuclear exchange? How many of us consider ourselves "expendable" for fulfilling impossible economic goals or for making a philosophical point?

As weapons get more sophisticated, so do their targets. Decades ago civilians prepared for nuclear war by burying themselves in holes in the ground; now they confront the issue above ground—in the streets.[591] The move from solipsism to involvement with the macrocosm is always a mark of progress. I doubt that a nuclear war, at least of the kind currently envisioned, will ever occur. Why? Because, among other reasons, *those of us who are its potential victims will not let it happen.*

Predestination?

In the foreword to *Technological Man*, the author was acclaimed for not trying "to get us off the hook by offering some streamlined doctrine of predestination."[592] Besides its praise for propagating exceptionalism, this statement, in typical indeterministic fashion, also misconstrues the meaning of predestination. What kind of world would allow us to escape the commands of nature? Only an indeterminist could imagine a hook that is no hook. Only an indeterminist could see humanity as part of nature and not part at the same time.

The Scientific Worldview I have been describing leaves no room for "getting off the hook" even if we wanted to. That delusion, for those who have it, is just as much an activity of nature as any other. The solipsist's or fatalist's tendency to lean back and "let nature take its course because it is all determined by the univironment anyway" is also determined by matter in motion. For indeterminists, this is just as good an excuse for inactivity as any other.

The extreme in this direction was developed by John Calvin in the sixteenth century, who also saw a strictly ordered world. The creator in all its omnipotence would not leave anything to chance. A sampling of Calvin: "Predestination we call that eternal decree of God by which He has determined in Himself what is to become of every human individual."[593]

Calvin, too, worried about streamlined doctrines—those not his own. And like the high priests before him, he peddled a special, schizoid plea to his constituency: "To be ignorant of things which it is neither possible nor lawful to know is to be learned; an eagerness to know such things is a species of madness."[594]

Although this was a nice palliative for the ignorant, it didn't prevent them from eventually learning the things Calvin didn't want them to know, just as indeterministic criticism hasn't prevented scientists from trying to develop "streamlined doctrines" and workers from learning of their own exploitation.

Calvinism was the zenith of the indeterministic view of predestination. When brought to its logical conclusion, neither faith nor action was of any use in changing the course of events. As with all fatalistic doctrines, Calvinism was rejected on the grounds of practical uselessness.

Laplace later devised the classical version of determinism, implying a form of predestination from which dialectical materialists escaped by endorsing Aristotle's idea of absolute chance. According to Engels, "determinism … tries to dispose of chance by denying it altogether. According to this conception only simple, direct necessity prevails in nature … an irrevocable concatenation of cause and effect."[595]

In Engels's opinion, "With this kind of necessity we likewise do not get away from the theological conception of nature. Whether with Augustine and Calvin we call it the eternal decree of God, or Kismet as the Turks do, or whether we call it necessity, is all pretty much the same for science."

But it is not really "pretty much the same for science," because, as scientists, we have to give reasons for the motions we see all around us. We can no more properly say that the cause of an effect is "chance" than we can say that the cause is "god." In either case, we are merely naming what we do not know. And because every effect has an infinite number of causes, there must always be some that are unknown to us. The determinist believes that these unknown causes are physical, natural, while the indeterminist does not.

The theological conception emphasizes the "pre" in predestination, thus implying a subjective, conscious intent. The scientific conception emphasizes the "destination" in predestination, thus implying an objective nature. As we have learned, in an infinite universe no microcosm can travel in a straight line forever. All are "destined" or "predestined" to be "deterred" or "determined" by other microcosms. For every departure there must be an arrival. All things, except the infinite universe itself, must have an end. The real world forces the objective view of predestination upon us. Only fools believe that they are not "predestined" to die. The submicrocosms within our bodies diverge from us per the Second Law of Thermodynamics. And following the complement of this law, an *infinity* of supermicrocosms is already in motion, converging on us. Eventually, a few of these will seal our fate. No intelligence could store the *infinity* of information required to predict the exact time and place of this last collision, but we are positive it will happen.

The subjective connotations of the word "predestination" make it unsuitable for describing the scientific conception of the orderly universe. "Predeterminism" certainly is no better, and the word "determinism," has been given so many microcosmic and macrocosmic appendages (e.g., "biological," "environmental," and "economic") that it, too, is usually inadequate. "Univironmental Determinism," on the contrary, sums up the situation without theology and without claims of omniscience: *the motions of the microcosm are determined by the main features of the microcosm and the macrocosm*.

Engels's objections to predestination and determinism involved the usual allusions to fatalism. But, of course, fatalism ultimately proves to be the philosophy of no one, a philosophy without a microcosm. It denies that the human microcosm has within it the matter in motion to influence the macrocosm. It treats humans, not as the microcosms they are, but as inert bodies that are bounced around helplessly, undergoing no internal change whatsoever. Fatalism is as outmoded as classical mechanism. Like other idealistic philosophies, fatalism is more successfully used as a weapon than as a ration.

Requiem for Exceptionalism

In conclusion, the myth of exceptionalism permeates Western thought to its detriment. The philosophical and scientific confusion engendered by this myth is typically found in grand pronouncements on humanity, its place, and its future. This mental block hampers the frontiers of science, especially those involving studies of the origin of life and the mechanism of evolution. We may envision relative dichotomies to conveniently study chemical, biological, and cultural evolution, but we don't need to believe that these dichotomies are absolute.

We don't need to consider ourselves both part of and not part of nature at the same time. We don't need to believe that, with the advent of consciousness, we can now step outside evolution, go under it, rise above it, or stop it. On the contrary, we should view ourselves and our environment as a univironment, an interacting unity in which all our actions are evolutionary.

Someday, the myth of exceptionalism will be rare among educated people. It will fall first in scientific specialties where it presents the greatest hindrance to progress. It will fall last in those areas of human endeavor in which certain powerful individuals benefit by spreading beliefs in acausality, free will, ghosts, and the joys of ignorance. To reject exceptionalism is to become a Univironmental Determinist in theory as well as practice.

Chapter 14

The Last Chapter

> The philosophers have only *interpreted* the world in various ways; the point, however, is to *change* it.[596]

The last chapter in philosophy concerns the relationship between fatalism, determinism, and solipsism. As their contribution to philosophical struggle, modern indeterminists generally dismiss determinism as fatalism. They conveniently forget that fatalism is a philosophy without a subject, and thus is no more useful than the other extreme: solipsism, the philosophy without an object. Both fatalism and solipsism are indeterministic. In pure form they are equally ineffective as guides to action. That is their function in the universe: to prevent change.

We are born into a world not of our own making; the more dissatisfied we are with that world, the more anxiously we seek to change it. Scientific philosophy has helped to produce the changes wrought by the Industrial-Social Revolution during the last two centuries, but its effectiveness has been blunted by the macrocosmic errors of classical mechanism and the microcosmic errors of systems philosophy. To change the world as rapidly as possible we must insist that, theoretically, macrocosm and microcosm are equally important. We must resist choosing between fatalism and solipsism, between objectivism and subjectivism, between antihumanism and humanism. Progressive philosophy must be consciously univironmental as well as consciously deterministic.

Humanity has always needed to know how the world works. It is no accident that, despite historical shifts in emphasis, successful scientific predictions relate the *main* features of the microcosm to the *main* features of the macrocosm. It is no accident that Univironmental Determinism, the Scientific Worldview, should arise out this naturally occurring process. We look at the thing itself, then we look at its surroundings and *vice versa*. The macrocosm impacts the microcosm; the microcosm impacts the macrocosm. Our method of viewing the world and the mechanism by which the world works gradually and inevitably become one and the same.

This philosophy, this mechanism of evolution, is at once singularly simple and infinitely complex. What could be simpler than the proposition that what happens to a thing is determined by the matter in motion within and without? Where else could one look? What could be more complex than the proposition that the motions of a thing have an infinite number of causes both within and without? Who could list but a few of them? Univironmental Determinism is the Scientific Worldview because it shows us the effective way to look at things and their motions.

Summary of the Scientific Worldview

Briefly let me trace the steps leading to the conclusion that the Scientific Worldview is the philosophy of Univironmental Determinism, the mechanism of evolution. I began by examining the age-old debate between determinism and indeterminism. Determinists believe that there are causes for every effect, while indeterminists believe that some effects, human decisions in particular, may not have causes. As we have seen, the struggle between these two views is interminable, but determinists see a spiralic progression that clearly favors determinism. Indeterminism is forced to yield as scientists discover more and more causes for effects that previously had no known causes. Still, indeterminists can continue to advocate the *argumentum ad ignorantiam* because, in an infinite universe, there are always effects for which causes remain to be discovered.

The world stands conspicuously divided on the question of determinism. Mixtures of religious pragmatism and atheistic existentialism oversee the capitalist world, while varieties of dialectical materialism advance the socialist world. Since the beginning of the twentieth century, modern science, headquartered in the New World, stems the philosophical tide even as it provides the technological advancement necessary for material wellbeing. Led by physics, cosmogony, and the popular press, established science and religion have mounted a major shift toward a type of indeterminism, which, according to the argument developed in this book, must stand or fall along with the economic system that promoted it.

In 1989 the Industrial-Social Revolution passed the halfway point in its development. No longer will there be exponentially increasing numbers of mouths to feed. No longer will there be an exponentially increasing demand for food, shelter, and clothing. As the microcosm of human population comes into line with the macrocosm of natural resources, production will come into line with consumption. Microcosmic thinking and macrocosmic thinking will yield to univironmental thinking. The twenty-first century will see a major renaissance of determinism and we will all be the better for it.

The foundation of this twenty-first-century philosophy obviously will be different from that of the current wisdom. In the deterministic view, all arguments are founded on assumptions that, in an infinite universe, can never be completely proven. As I have shown, the current assumptions on which science is based reveal little consensus. Even after a particular assumption is agreed upon, its interpretation becomes a part of the determinism-indeterminism battle that rages at every twist and turn in nuance. The deterministic side of the argument insists, first, that scientific assumptions form a circular unity with minimal contradiction, and second, that any assumption leading to a free will argument must be rejected as indeterministic and therefore unscientific. Because the Ten Assumptions of Science are the philosophical starting points for the Scientific Worldview, it is worth repeating them.

Table 14-1. The Ten Assumptions of Science.

1.	*Materialism*	The external world exists after the observer does not.
2.	*Causality*	All effects have an infinite number of material causes.
3.	*Uncertainty*	It is possible to know more about anything, but impossible to know everything about anything.
4.	*Inseparability*	Just as there is no motion without matter, so there is no matter without motion.
5.	*Conservation*	Matter and the motion of matter neither can be created nor destroyed.
6.	*Complementarity*	All bodies are subject to divergence and convergence from other bodies.
7.	*Irreversibility*	All processes are irreversible.
8.	*Infinity*	The universe is infinite, both in the microscopic and the macroscopic directions.

9.	*Relativism*	All things have characteristics that make them similar to all other things as well as characteristics that make them dissimilar to all other things.
10.	*Interconnection*	All things are interconnected and interrelated; that is, between any two objects exist other objects that transmit matter and motion.

Taken as tentatively "true," these assumptions underlie a perspective differing from the first scientific abstraction, classical mechanism, and the current one, systems philosophy, in its insistence that the motions of a thing are equally dependent on the motion of matter within and without. In its most reduced form, this new abstraction is neomechanics, the version of mechanics compatible with the Ten Assumptions of Science and proposing that all events result from combinations of the six possible univironmental interactions. In its most expanded form, this new abstraction is Univironmental Determinism, the universal mechanism of evolution.

This philosophy/mechanism is the logical replacement of the currently accepted mechanism of evolution, neo-Darwinism, which is too specific, ignores important features of the univironment, and has proven inadequate even in biology. Although Univironmental Determinism hypothesizes an infinity of supermicrocosms impinging on any particular microcosm, as well as an infinity of submicrocosms affecting it from within, it also maintains that not all these are equally significant. Thus, the philosophy of Univironmental Determinism is realized in practice through univironmental analysis, the attempt to predict the motions of the microcosm by evaluating the main features of the univironment. As with the older scientific worldviews, we discover the "main features" only through observation and experiment.

When the method of univironmental analysis was used to evaluate currently popular theories generated by systems philosophy, the contradictions between these two ways of looking at the world became clear. This was especially true when the focus was on the archetype of systems philosophy, the Big Bang Theory of the origin of the universe. The Big Bang was shown to be the logical product of major system-oriented theories. The shear breadth and daring of its microcosmic speculation will never be surpassed. The theory of the eventual heat death of the universe, for example, incorrectly generalizes from the Second Law of Thermodynamics, which, from the systems point of view, is a law of divergence. In an infinite universe, however, the divergence from one place is seen as a convergence on another. The ramifications of the univironmental view extend to theories of gravitation and light. The Univironmental Theory of Gravitation considers gravitation as a push rather than a pull—challenging the attraction/curved space hypothesis of systems philosophy. Similarly, the Doppler interpretation of the galactic redshift is shown to be dependent on inadequacies in the current theory of light, particularly its assumption that space is completely empty. The replacement of its supporting theories by those more compatible with Univironmental Determinism will destroy the Big Bang Theory and lead to its replacement by the Theory of the Infinite Universe.

Since the universe had no beginning and will have no end, there is no reason to hypothesize a special creation in either the inorganic or the organic realm. The link between the two occurs in biopoesis, the origin of life from inorganic chemicals. Univironmental analysis demonstrates this transition, first in emphasizing the similarities between the living and the nonliving by using the physicochemical model, and second in showing how the *irreversibility* necessitated by an infinite universe produces complexity through convergence. In the process, I rejected neovitalism, the indeterministic tendency to view the causes of behavior microcosmically rather than univironmentally.

Humans also can be viewed as microcosms, and this view results in a new definition for needs as univironments resulting in behavior. Univironmental Determinism provides scientific solutions to problems involving consciousness, knowledge, ideas, ethics, and altruism, which must forever remain paradoxical to indeterminists.

Univironmental Determinism helps us view the rise of civilization as a result of increasing socialization attendant on the industrializing stage of evolution in which the expansion of the Social Microcosm begins and ends on a global scale. Today, indeterminists—some dialectical materialists among them—are distinguished by their belief in exceptionalism, the notion that humanity is supposedly exempt from Univironmental Determinism. The Scientific Worldview, however, maintains that we are part of an orderly system. Humanity will neither stumble into suicidal oblivion, nor will it rise above matter or stop evolution.

Univironmental Determinism as a Personal Philosophy

Indeterminists would have you believe that the Scientific Worldview can have nothing to do with your personal life. The opposite is true. We are all microcosms, infinitely complex physicochemical entities, and all our interactions with the macrocosm are physicochemical reactions. If the macrocosm becomes warm, we sweat. If it becomes cold, we shiver. What happens to us depends on only two things: the within and the without.

The naturally evolved philosophy of Univironmental Determinism impacts on us and changes our consciousness, replacing our dreams of free will with the actual feeling of freedom gained only through action. As determinists, we know that all effects have causes; each and everything we do changes the world. By changing the macrocosm, we not only irreversibly change our surroundings, we indirectly "change ourselves." As determinists, we trade the acausal and inexplicable free will for the causal and explicable feeling of freedom.

With this philosophy we can be "our own chemists;" we can gain the feeling of "controlling our own lives." Because we realize that the self and the world form an inseparable univironment, we can avoid viewing personal success or failure microcosmically, as something independent of our surroundings. For us, the answers to human fulfillment do not lie solely in *The Virtue of Selfishness*,[597] *Winning Through Intimidation*,[598] or *Looking Out for #1*.[599] We realize that we cannot wreak havoc with the macrocosm without wreaking havoc with ourselves. The macrocosm always wreaks back.

The days of the microcosmic personal viewpoint are drawing to a close. We must develop a sensitive view of the macrocosm, of what it can do for us and to us. In doing this we can ill afford to waste time on "things" that don't exist and on speculations long since discredited. The Scientific Worldview does not demand an extensive knowledge of scientific details. Rather, it encourages the consideration of a few reasonable assumptions by which the univironment may be judged. From this point of view one avoids quibbling about the merits of such erroneous propositions as astrology, reincarnation, and extrasensory perception—they are dismissed out of hand. Instead of considering the positions of faraway stars and speculating on the non-mechanical transfer of information, we focus on the nearby features of the univironment that have such great potential for developing and maintaining human happiness.

Understanding oneself and one's environment is a science. Like all other sciences, its success depends on the application of theory, observation, and experiment. Because we are all scientists, we use the scientific method in our personal lives even though we may do so only subconsciously. The Scientific Worldview merely attempts to be an explicit statement of what we have been doing all along. Its goal is to transform our subconscious behavior into conscious behavior and thereby improve its effectiveness.

Theory

All people have some kind of theory about themselves and their relationship to the world. The more we consciously recognize the necessity for a personal theory, the more we will consciously develop one. If you believed, along with indeterminists, that most of what happens to you is acausal, a matter of absolute chance, then you would remain as a passive object at the mercy of the macrocosm. If you believed, along with determinists, that what happens to you is causal and partially predictable, you would act to influence those events. Univironmental Determinism, of course, is only a barebones guide—personal theoretical development is necessary because each of us is unique.

In some ways we are always more and in other ways we are always less than we think we are. Our degree of success and happiness depends partly on the accuracy of our theories about ourselves. As with all univironmental analyses, we have a tendency to make either of two kinds of mistakes of overemphasis: microcosmic or macrocosmic. People with superiority complexes overemphasize their capabilities, while those with inferiority complexes underemphasize them. Good mental and physical health requires a balanced, univironmental view of ourselves and our surroundings. The development of an adequate personal theory helps us to achieve this balance. It can be a matter of life and death.

Observation

No theory can be developed without observation, the sensory connection between the microcosm and the macrocosm. But the eye never sees itself. How does a microcosm go about observing itself? Univironmental Determinism teaches us that half of our identity is supplied by the macrocosm.

As we observe the people about us, we invariably see that they are more like "us" than "them." It is no accident that "birds of a feather flock together," that both parties to a marriage often look similar, that people of similar abilities and interests are close friends. Sometimes we are shocked by such revelations. People who complain that they are surrounded by incompetents are indirectly saying something about themselves.

Observations about ourselves are always useful to us. It seems unlikely that we could have too many of them. Unfortunately, what we observe is dependent on what we are looking for—in other words, the theoretical basis for the search. The obvious problem here is that it is impossible to be purely objective about ourselves. The way to overcome some of this bias is to experiment.

Experiment

Personal observations and theories constitute the knowledge on which we act. We all know the consequences of acting with insufficient or inaccurate information, so it behooves us to be cautious. We are continually reminded of those who were not. On the other hand, all information and theory is to some degree insufficient and inaccurate. Too much caution, like too much of anything, often proves as disastrous as too little. The macrocosm is continually in motion and ultimately forces action on the microcosm—prepared or not. At some point we must act. We must put our theories and observations about ourselves to the test. Unrealistic theories meet with obvious failure during experimentation. Theories and dreams that meet with a hostile macrocosm either are altered or become extinct. Theories finding a measure of acceptance achieve a temporary "univironmental equilibrium," but are forced to change when the univironment inevitably changes.

Life is an experiment. Everything we do is an experiment—we are all scientists. The more we make the idea of experimentation part of our personal lives, the more we feel like the experimenter rather than the experimentee, the manipulator rather than the manipulatee. Because experimentation requires action, it must also produce the feeling of freedom. But belief in the efficacy of experimentation is dependent on the belief in *causality*. Those who truly believed in ***acausality*** would never experiment—they would never act. That is why the call to inaction is always expressed in indeterministic terms. Solipsism, the microcosmic philosophy, and fatalism, the macrocosmic philosophy, both give the same fraudulent advice: nothing you do can have any real effect on the world. The scientific truth, however, is just the opposite: everything you do has an effect on the world.

Some say that the meaning of life can be found in the pursuit of happiness. When we are unhappy, dissatisfied, we act to remove that dissatisfaction. What appears as the search for happiness is really the avoidance of unhappiness—a search for univironmental equilibrium, for a time when we achieve temporary equilibrium with the macrocosm.

It is often said, particularly by those who wish to prevent incursions into their bailiwicks, that the Scientific Worldview cannot account for emotions, for art, or for beauty. They tend to speak of these phenomena as though they were not produced by matter in motion, as though they were supernatural. In challenging this view, classical mechanists made a foolish claim: all the causes of these phenomena, too, would be discovered. In challenging this view, systems philosophers made an equally foolish claim: most of the causes of these phenomena were physical, but the remainder were a result of pure chance, which could be either physical or nonphysical. In denying the supernatural, Univironmental Determinism claims that the causes of these effects are infinite in number. Improved scientific accounts of aesthetic phenomena will be achieved, but, as with all phenomena, complete accounts will be impossible. Infinity assures a plethora of mystery and fertile ground for the indeterminists of the future, but we must continue to dismiss those who allege a special pipeline to the supposed supernatural.

Because emotions are such complex events and often do not reveal even their primary causes, they have been, in accord with exceptionalism, commonly left out of scientific explanations. But today, as scientific philosophy and evolutionary philosophy become one, the significance of emotion becomes paramount. The emotional experience produced by pain, for example, is absolutely required for the highest forms of evolution. Without pain we would continually damage our bodies to such a degree that we could no longer negotiate the macrocosm as the complex microcosms that we are. The varied and complicated activities of humans surely could not have evolved without also evolving pain in addition to the more complicated emotions. Indeterministic fears that *Homo sapiens* eventually may be replaced by cold, insensitive mechanical robots are unfounded. Whatever life forms replace us will be *more* sensitive and *more* emotional, not less so.

Our personal experiments with life require emotions for directing us into the most appropriate space-time positions—toward univironmental equilibrium. As we have seen, it is characteristic of mechanistic theories that they overemphasize the external and underemphasize the internal. Coming from such a point of view, Darwinians saw emotions as merely peripheral to evolution—certainly not a crucial part of it. Succumbing to political pressure, even Darwin himself was quick to reassure idealists that the clash of microcosms could be painless; "When we reflect upon this struggle, we may console ourselves with the full belief, that the war of nature is not incessant, that *no fear is felt* (emphasis mine).[600]

The correct mechanism of evolution must include the obvious fact that fear is a primary motivator of conscious beings. We cannot live without fear. Evolution does not progress in spite of emotionalism and so-called "irrationalism," but because of it.

Well-adjusted people do not deny their emotions. They heed them. Emotions are one of the keys to success in any experiment in personal development. They help to tell us what we like and dislike and what we can do and cannot do. Knowing that emotions are produced by conditions in the univironment, rather than by some mysterious, acausal "phenomenon," leads us to view them as though they are increasingly under our control. Ironically, we cease being "prisoners of our emotions" only when we admit that exactly that is the case.

We can achieve the feeling of controlling our emotions and our lives only by changing our environments. We can move toward those environments we enjoy and away from those we do not. We can move toward what we wish to be and away from what we do not wish to be. We all tend to do this subconsciously, but how many can say that we do it consciously, with a definite goal in mind?

It is no accident that students are found among students, writers among writers, artists among artists, progressives among progressives, and reactionaries among reactionaries. Obviously, if you want to be a professional scientist, for example, you must associate with professional scientists; you must do what professional scientists do. Likewise, if *all* your friends are conservatives and *all* your information reflects the conservative viewpoint, you will be a conservative. You will remain one until your environment changes, even if that change only amounts to one comment by one person or one sentence in one book.

Groups not only make their members more similar to each other, they also provide shelter from the storm. Whenever we are criticized or ridiculed for our strange ideas, customs, or appearance, we seek univironmental equilibrium among those who are less abusive. To continue existing, a microcosm needs a community of friends. Everything in existence is part of a larger macrocosm whose immediate environs are not completely antagonistic to it. Thus, each human microcosm is part of the Social Microcosm and each of us requires a social philosophy to survive.

Univironmental Determinism as a Social Philosophy

During the first half of the global demographic transition (1750–1989), the expansion of the Social Microcosm was so explosive that it appeared as though it would never end. To suit the occasion, society developed a social philosophy and even a cosmology commensurate with that expansion. During the next two centuries, however, the Industrial-Social Revolution will draw to a close. During this period the Social Microcosm will be forced to give up its microcosmic preoccupation as it discovers the part that the macrocosm plays in its own evolution. It will have to devise a new social philosophy and a new cosmology to cope with this new "era of limits."

What will be the new social philosophy? With the widespread availability of nuclear weapons, our national governments can no longer afford the myopic bias of systems philosophy. To survive, nations must no longer view themselves as isolated, "self-organizing," and independent. It is now becoming increasingly dangerous for governments to make the traditional microcosmic mistakes—to act in selfish disregard of others. A nuclear attack on the macrocosm would be, in effect, an attempted suicide. To get through the twenty-first century, we will need citizens and leaders who can think univironmentally.

What are the signs that a social philosophy based on Univironmental Determinism is developing? If it is true that Univironmental Determinism is the mechanism of evolution, then it follows that social philosophy, too, will be pushed in that direction. As demonstrated in chapter 2, the determinism-indeterminism struggle moves slowly and spirally in favor of determinism as the Social Microcosm passes through the juvenile stage of its development. As we broaden our horizons, we are forced to include more and more information derived from the physical universe in our conceptions of the world.

We evolve by learning from our microcosmic and macrocosmic mistakes. Deterministic philosophy, too, tends to alternate between periods of overemphasis on the macrocosm and periods of overemphasis on the microcosm. The rejection of classical mechanism and the impending rejection of systems philosophy must lessen the immensity of such mistakes, but it would be delusive to maintain that additional, but perhaps smaller, shifts in emphasis would not occur. In the preface I confessed to a bit of fatalism that accompanied my initial rejection of systems philosophy. I doubt that anyone or any social microcosm could give up the systems viewpoint without going through a similar phase. Thus, I expect there to be a period of macrocosmic reaction to systems philosophy with which I can sympathize, but nevertheless will oppose. To survive, we need a balanced philosophy. Fatalism is no better than solipsism.

The new social philosophy *must* be Univironmental Determinism. In global terms we can no longer afford to propose an absolute dichotomy between *us* and *them*, and consequently risk overemphasizing the significance of *us* at the expense of *them* (or *vice versa*). How will this develop? As always, through trial and error. We have a long way to go before we achieve this balance.

In the preface I also mentioned that the immediate stimulus for this work was the advent of sociobiologist E. O. Wilson's supposedly scientific defense of the status quo. By extending his microcosmic philosophy to the point of absurdity, Wilson inadvertently forced me to think seriously about the way I had been doing science. I failed to appreciate both his conclusions and the so-called "deterministic" way in which he arrived at them. His liberal critics also taught me an unintended lesson. They rightly accused him of cultivating "'philosophical ease' toward the unfolding of contemporary human affairs."[601] They professed themselves "unable to maintain the ease required to accept discrimination, militarism, and social injustice as natural and inevitable reflections of some vast insensate sociobiological scheme of things." In voicing their social concerns, with which I agreed entirely, they somehow felt compelled, as it were, to take humanity out of nature and throw it to the winds of ***acausality***. But what kind of social philosophy would be effective if it did not assert that social injustices were natural and inevitable, and that their eventual removal was also natural and inevitable?

Biological microcosms are nothing if not sensitive. The recognition of social injustice requires a high level of sensitivity, and sensitivity, as recognized by Wilson's critics, is not particularly conducive to ease. What was needed was an even higher level of sensitivity, one that recognized the deterministic means by which injustices are overcome. A proper scientific critique of sociobiology would also lead to the proper social philosophy.

Wilson used the myth of exceptionalism to support established social customs, while his critics used it to deny the naturalness of their own emotions that nevertheless contributed to changing those customs. By recognizing the connection between Wilson's systems philosophy and social injustice, his critics have achieved the first step in alleviating some of those injustices. By suggesting that their own emotions were not a natural and inevitable consequence of all that went before, they not only directed us down the wrong path, but they revealed their lack of faith in the causal significance of their own actions.

In a way, it is ironic that even the most microcosmic thinker cannot refrain from irreversibly changing society. In a fit of microcosmic rage, one could spurn social attachments, preach the virtues of individualism, and display the most outrageous greed, but one would still be contributing to the socialization of society. Even bad examples are useful. Invariably, those who only "look out for number one" end up teaching others to look out for *them*. Society protects itself from such individuals by developing ethics, rules, laws, red tape, and prisons to be used against them. As we have seen, rules are the cooperative results of competition. One cannot defend society's rules without also defending society as it is presently constituted; one cannot challenge the rules without challenging the society.

We all must operate, not only as individuals, but also as parts of social groups. As we have seen with the recent rise of the political right, when it is time to socialize, to act as part of a greater microcosm, people first revert to individualistic methods to do things that only a group could do. On the other hand, when it is time to desocialize, people tend to use group methods to do individual activities. Nonunion workers, for example, endure low wages and poor working conditions, partly because the individualistic philosophy that they have been taught is not suited to the collective nature of their new jobs. "Self-help" may be useful at one time, but "group-help" may be required at another. It is ridiculous to maintain an individualistic, microcosmic point of view in the face of tasks that only a group could perform.

How do we determine whether individual or whether group action is appropriate in a particular situation? We do it through the scientific method: *theory*, *observation*, and *experiment*. Theory attempts to generalize all the salient, noncontradicting facts about the main features of the univironment of concern. Observation passively interacts with that univironment to check if its "main features" resemble the "main features" in the theory. Experiment actively interacts with the univironment of concern by altering some of its "main features," observing the results, and expanding the theory to accommodate the added complexity. Everyone, at least subconsciously, performs these activities each day. We must continually reexamine the appropriateness of our actions in the social context. We are all scientists.

Univironmental Determinism and the Future

Whether we should emphasize the individual or the group approach to solving our problems depends on changes within the univironment. We obviously live in a world being rapidly socialized. Increases in population density require collective action. Where this move to collective action lags, human suffering ensues. Thus we observe starvation and malnutrition in those areas of the world in which the industrializing stage of evolution was introduced only recently. People accustomed to a rural, relatively individualistic way of life are thrust into an urban macrocosm. Newly urbanized social microcosms do not contain the customs and ideas required for urban, collectivized living. And so they suffer until they adapt to the urban macrocosm. This they do only after they have assimilated or developed the knowledge that allows them to survive in the new environment. This knowledge, of course, is heavily deterministic, giving urban areas the well-earned reputation for being places of heathen activity.

Thus, birth control, anathema to the Catholic Church, becomes standard practice after a generation or two of urban living. The ongoing preachments of the Pope will become less and less effective as the Social Microcosm completes its demographic transition. The microcosm of Catholic doctrine cannot survive in a world in which birth control is becoming a requirement for existence. The pressures for change within the Vatican mount daily, not so much because of the suffering abetted by its policies, but because those sufferings have diminished for those who have rejected them.

We live in a univironmentally deterministic world. The tremendous economic and social power of internationally organized groups allows them to transform parochial existence into socialized existence. Humanity is becoming better and better organized on a worldwide basis, gaining legitimacy for the claim that it is immoral to be self-centered, neovitalistic, and ignorant of the concerns of fellow humans. International communications are destroying much of the alienation that once was. We find it increasingly difficult to avoid identifying with humans everywhere. In our own living rooms we hear and see the victims of disaster and find it impossible to be unconcerned. We ask, what if that happened to me? The vision creates within us an unhappiness that can be removed only through action. These actions, in turn, further strengthen the bonds between people, preparing them for the next blow to be dealt by the macrocosm.

It is impossible for matter in motion to allow us to rest in peace. Life demands the solution of one problem after another, stability follows instability, and happiness follows unhappiness. As microcosms—infinitely complex physicochemical entities—we realize we are entirely controlled by the motions of matter within and without. We look nowhere else for the solutions to our problems because there is nowhere else to look.

The Scientific Worldview, Univironmental Determinism, makes us increasingly sensitive to our surroundings, a process found throughout nature, and the process by which we evolved and will continue to evolve. This sensitivity includes our relations with our fellow inhabitants: our friends and our enemies. As we become one world, the concerns of humanity increasingly become our individual concerns and the concerns of the individual become the concerns of humanity.

The essence of the Scientific Worldview lies not in fancy mathematical equations, in unpronounceable words, or in demonstrations of laboratory wizardry, but in its practical application to everyday life. Our growing awareness and acceptance of Univironmental Determinism teaches us the great significance of our surroundings on our individual and collective wellbeing. Marx said that philosophers talk about the world, but that the point was to change it. Indeed it is and we will continue to do so. From the laziest to the most active, we all change the world every microsecond that we exist. Humanity's newfound consciousness is an inevitable, naturally evolving result of all that went before. As always, we have no choice; we *will* change the world. As the Social Microcosm approaches maturity it will continue to achieve an accommodation with its macrocosm.

Although the universe is infinite, the resources in any one place are not. Ten billion of us must learn to share the planet. The inevitable conflicts that will develop on the way will be seen as increasingly juvenile and anachronistic. As always, the result of that competition will be cooperation. War eventually will become obsolete and we will spend the time and resources in tending to the inevitable problems that continually arise despite anyone's best efforts. Is there a utopia in our future? Definitely not. Overall, will things be better than they are now? Not really, they just will be different. "Better" is a subjective word. Is it better to live 80 years in the city than 40 years in the wilderness? Is it better to have bureaucratic red tape instead of war? Is it "better" to be an adult than a teenager? In hindsight, we probably will think, "how could we have been so stupid?" But that is hindsight. We know better now; let's make the best of it.

There are bound to be objections to the ideas expressed in this book,[602] as there are to the changes wrought by science in general. Science—knowledge—rearranges power: the ability to act. As always, those individuals and groups who gain an understanding of the Scientific Worldview gain power while those who renounce it lose power. The inevitable and growing acceptance of the Scientific Worldview accompanies the completion of the Industrial-Social Revolution on which it is mutually dependent. Like the Industrial-Social Revolution, the Scientific Worldview discards traditional speculations while opening new vistas to previously unattainable horizons.

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Appendix I

Glossary

Ambient. "Surrounding on all sides."[603]

Agnosticism. "The doctrine that it is not possible to attain knowledge of a subject, usually god. The term was coined by Thomas Huxley to denote modest ignorance and a state of suspended judgment regarding ultimate issues."[604] Agnosticism admits to no assumptive basis for making philosophical choices and thus appeals to those in transition between opposing philosophies.

Atheism. The belief that denies the existence of god.

Beaker. A wide-mouth laboratory container.

Consupponible. A term applied to two or more assumptions apparently not contradicting one another. A constellation or group of assumptions is consupponible if it is logically possible for those who assume any one of them to assume all the rest.[605]

Cosmogony. "A theory of the origin of the universe."[606]

Cosmology. "A branch of metaphysics that deals with the universe as an orderly system."[607]

Demography. "The statistical study of human populations especially with reference to size and density, distribution, and vital statistics."[608]

Desocialization. The process of leaving a social group or environment.

Determinism. The view that every event in the universe is completely dependent and conditioned by its causes (i.e., that the causal principal is universal). More specifically, the doctrine that human behavior (including all judgments and choices) is determined by physical antecedents which are its causes. Opposed to indeterminism (the belief in complete freedom of the will) and to be distinguished from fatalism (the belief that events are predetermined or predestined, and therefore inevitable regardless of our efforts to prevent their occurrence).[609]

Dialectic. "Any systematic reasoning, exposition, or argument that juxtaposes opposed or contradictory ideas and usually seeks to resolve their conflict."[610]

Dialectical Materialism. The deterministic philosophy founded by Marx and Engels, in which matter—that is, the observable world—is considered real in its own right, neither deriving its reality from any supernatural source, nor dependent for its existence on the human mind. Space and time are considered as forms of the existence of matter. The term dialectical expresses the dynamic interconnectedness of things and emphasizes the universality of change. Everything is in the process of self-transformation because it is made up of opposing factors of forces the internal movement of which interconnects everything and changes each thing into something else. Investigation reveals basic recurrent patterns of change expressible as the laws of materialist dialectics relevant to every level of existence:

> 1. Law of interpenetration, unity and strife of opposites. (All things, being complexes of opposing elements and forces, have the character of a unity considered temporary and relative, while the process of change, expressed by interpenetration and strife, is continuous and absolute.)
>
> 2. Law of transformation of quantity into quality and vice versa. (The accumulation of slow, quantitative changes in nature eventually precipitates new qualities in a transition appearing as a sudden leap. The new quality is considered as real as the original quality but it is not mechanically reducible to it.)
>
> 3. Law of negation of negation. (Each transformation is part of an unending development in which each synthesis resolves the contradictions contained in the preceding synthesis.)[611]

Dualism. "A theory that considers reality to consist of two irreducible elements or modes."[612]

Empiricism. A proposition that the sole source of knowledge is experience and generally denying that there are any necessary presuppositions of all knowledge.[613] Empiricism is popularly associated with the indeterministic belief that mental constructs, assumptions, hypotheses, and theories are not products of experience and therefore are not reliable guides to investigation.

Fideism. The apparent reliance on faith rather than reason.

Free Will. The indeterministic doctrine that a person's will or capacity for choice is to some extent independent of determination by material causes.

Idealism. "Any system which reduces all existence to mind or thought. This may be either a single, absolute mind or thinker or a plurality of minds."[614] "Subjective Idealism (acosmism) holds that Nature is merely the projection of the finite mind, and has no external, real existence."[615]

Immaterialism. "Doctrine of the non-existence of material or corporeal reality. Pure Idealism."[616]

Indeterminism. The belief that some effects may not have causes. Specifically, the belief in freedom of the will, the doctrine that a person's will or capacity for choice is independent of all determination whatsoever, and thus functions in a noncausal vacuum.[617]

Isotropic. Equal in all directions.

Materialism. A theory that physical matter is the only or fundamental reality and that all being and processes and phenomena can be explained as manifestations of or results of matter.[618]

Mechanism. Theory that all phenomena are the result of matter in motion and totally explicable on mechanical principles.[619] In its classical form, mechanism was the scientific worldview of the eighteenth and nineteenth centuries and tended to stress external interactions over internal interactions.

Naïve Realism. "The view of the man in the street. This view is an uncritical belief in an external world and the ability to know it."[620]

Nature-nurture Debate. The argument between hereditarians (those who stress the internal constituents of the organism, particularly its genetic makeup) and environmentalists (those who stress the external environment of the organism) concerning the primary determinants of behavior.

Neomechanism. Theory that all phenomena are the result of matter in motion, but only partially explicable due to the infinite nature of matter and its motions. Neomechanism stresses external and internal interactions equally (See chapter 5).

Pantheism. "A doctrine that God and the universe are identical."[621]

Positivism. "A theory that theology and metaphysics are earlier imperfect modes of knowledge and that positive knowledge is based on natural phenomena and their properties and relations as verified by the empirical sciences."[622] Positivism generally claims that science is based on fact and that religion is based on faith, and rejects the view that both are founded on incompletely verifiable, opposed assumptions. In the extreme, positivism refrains from hypothesizing interphenomena; that is, entities or processes for which no direct evidence exists, but which may be theoretically required to connect phenomena for which evidence does exist.

Reductionism. “A procedure or theory that reduces complex data or phenomena to simple terms.”[623]

Socialization. The process of entering a social group or environment.

Space-time. A matter-motion adjective that is a deterministic abstraction or idealization (mental picture) relating the positions of things to the motions of all other things. Thus as I sit at my desk today, I have the same position as I did yesterday, but I have an entirely different space-time position. In a universe with an infinite number of things in motion with respect to all other things, space-time positions can never be duplicated. The space-time concept aids in visualizing the irreversibility of evolution along with the impossibility of “traveling backward in time.”

Spacetime. A matter-motion noun used by indeterminists in an attempt to objectify the unification of space and time. Because this is conceptually impossible, the term spacetime invariably takes on the characteristics either of space or of time generally unbeknownst to the user.

Submicrocosm. A portion of the universe contained within another portion of the universe.

Supermicrocosm. A portion of the universe outside another portion of the universe.

Systems Philosophy. Any belief that a portion of the universe may be isolated from all else and properly studied as a system, “a set of interacting elements that form an integrated whole.”[624] Also known variously as the “systemic approach,”[625] “systems theory,” “general systems theory,” “systems science,” “systems research,”[626] or “general systems thinking.”[627] Systems philosophy is the current scientific worldview, having grown from the defeat of classical mechanism in the ’20’s. Its formal recognition came with the publication of Norbert Wiener’s Cybernetics[628] in 1948 and the founding of the Society for General Systems Research in 1954.[629] Closely following its announced goals, systems philosophy tends to stress internal interactions over external interactions.

Theism. The belief in the existence of a god or gods.

Vitalism. “The biological doctrine that organic processes are not explicable in physicochemical terms, but can be accounted for only by assuming an unknowable, nonmaterial entity or substance, called variously the “psychoid,” “entelechy,” “élan vital” or “vital principle.” Opposed to mechanism.”[630]

Worldview. Modern translation of the German *Weltanschauung*. “A comprehensive conception or apprehension of the world especially from a specific standpoint.”[631]

Appendix II

Do You Understand Univironmental Determinism?

The following statements from the literature are either true or false according to the Scientific Worldview. Test your understanding of this point of view both before and after reading the book. Answers are at the end of the test.

1. Man's future is in his own less than competent hands.[632]

2. To a large extent the environment is fixed, and to this extent there is struggle for existence.[633]

3. The jumbling together of natural objects in a given region remains what it was before—a matter of chance.[634]

4. Although change proceeds along forever, its trend is always toward diversity.[635]

5. The electron is as *inexhaustible* as the atom.[636]

6. Selection may be applied to the family, as well as the individual.[637]

7. Every event occurring in the Universe, including those events known as mental processes, and all kinds of human action or conduct, are expressible purely in terms of matter and motion.[638]

8. We are unable to think of matter otherwise than as existing in a particular region of space.[639]

9. We know that the physical world, on the whole, is running down; it is approaching a state of ultimate disorganization.[640]

10. Fitness is a relational term: an organism's fitness refers to its fitness for a particular environment.[641]

11. Ant society is absolutely stable.[642]

12. As the coffee cools, mass is lost.[643]

13. But there need not have been a first event; we can imagine that every event was preceded by an earlier event and that time has no beginning.[644]

14. Gravity and inertia are one and the same.[645]

15. The extinction of species is as natural a part of evolution as is their creation.[646]

16. The world may have a population of about 7 billion people by the year 2000.[647]

17. Knowledge is a physical process.[648]

18. Our knowledge has made us increasingly autonomous in nature, and enabled us to create the worlds of culture. It has freed us from many of the bonds of biological existence and given us license to determine our own evolution.[649]

19. The part is not the whole in miniature and in essence.[650]

20. Automation … gives the production system the character of an autonomous, self-controlling system.[651]

Answers:

1.False2.False3.False4.False9.False11.False16.False17.False18.False20.False
5.True6.True7.True8.True10.True12.True13.True14.True15.True19.True

Scoring:

0 to 10 correct: Your philosophy is indeterministic.

11 to 20 correct: Your philosophy is deterministic.

Endnotes

[1] Huxley, *Man's Place in Nature*, 71.

[2] Ferkiss, *Technological Man*, 195.

[3] Throughout the book, each of the Ten Assumptions is represented by an italicized word, while its opposing assumption is represented by a word in boldface italics.

[4] See the glossary in the appendix for definitions of this and other technical terms.

[5] Mead, *Types and Problems of Philosophy*, 398.

[6] Goodfield, "Humanity in Science," 584.

[7] Engels, *Dialectics of Nature*, 209-210.

[8] Smith, *A Selection of Correspondence*, 460.

[9] Engels, *Anti-Duhring*;———. *Dialectics of Nature*;———. *Ludwig Feuerbach*; Lenin, *Materialism and Empirio-Criticism*; Marx and Engels, *Feuerbach*;———. *The German Ideology*.

[10] Engels, *Ludwig Feuerbach*, 20.

[11] Feyerabend, *Against Method*.

[12] Peirce, "The Doctrine of Necessity Examined," 33.

[13] Mead, *Types and Problems of Philosophy*, 52.

[14] Ibid., 306.

[15] Ibid., 318–19.

[16] Castell, *An Introduction to Modern Philosophy*, 531.

[17] *Webster's New Collegiate Dictionary*.

[18] But see especially: Marx and Engels, *Feuerbach*; Engels, *Anti-Duhring*;———. *Ludwig Feuerbach*.

[19] Engels, *Dialectics of Nature*.

[20] Ibid., 230.

[21] Ibid., 217-21.

22 Graham, *Science and Philosophy in the Soviet Union*; Konstantinov et al., *The Fundamentals of Marxist-Leninist Philosophy*, 176-81; Hörz et al., *Philosophical Problems in Physical Science*.

23 See Hörz et al., "Causality and Law" versus Talkington, "Causality and Law: A Critical Commentary."

24 Mead, *Types and Problems of Philosophy*, 445.

25 Castell, *An Introduction to Modern Philosophy*, 119–37.

26 Mead, *Types and Problems of Philosophy*, 423–32.

27 Planck, *Where Is Science Going?*

28 Borchardt, *The Ten Assumptions of Science*. For a summary, see: Borchardt, "Ten Assumptions of Science and the Demise of 'Cosmogony'."

29 Collingwood, *An Essay on Metaphysics*.

30 From Borchardt, *The Ten Assumptions of Science*.

31 Einstein, *Ideas and Opinions*, 266.

32 Berkeley, "Mind and Matter."

33 A person, unschooled in philosophy, who believes that the external world closely resembles one's perception of it.

34 *Webster's New Collegiate Dictionary*.

35 Planck, *Where Is Science Going?* 85.

36 Feuerbach, *The Essence of Christianity*.

37 Like empiricists, positivists contend that sense perceptions are the only admissible basis of human knowledge and that assumptions are unnecessary for describing the phenomena that we experience. Positivists hold that it is impossible to say anything about phenomena not yet observed. Being opposed to *interconnection*, a strict positivist would never hypothesize the existence of an atomic particle for which there is no direct evidence.

38 Reichenbach, *The Rise of Scientific Philosophy*, 42. With this passage, Reichenbach betrays the positivist doctrine, finding it necessary to discard his belief in no belief.

39 Russell, *Mysticism and Logic*;———. *On the Philosophy of Science*, 163.

40 Reichenbach, *The Rise of Scientific Philosophy*, 112.

41 Ibid., 113.

42 Peirce, "The Doctrine of Necessity Examined," 33.

43 Ibid., 41.

44 Reichenbach, *The Rise of Scientific Philosophy*, 183.

45 Ibid., 307.

46 Ibid., 163.

47 Pauling and Zuckerkandl, "Chance in Evolution," 120.

48 Blandshard, "The Case for Determinism," 9.

49 Quoted in Castell, *An Introduction to Modern Philosophy*, 520.

50 Bohm, *Causality and Chance in Modern Physics*.

51 Hawkins, "The Thermodynamics of Purpose," 116.

52 Bohm, *Causality and Chance in Modern Physics*, 20, 22.

53 Heisenberg "Uber Den Anschaulichen Inhalt Der Quantentheoretischen Kinematik Und Mechanik."

54 Quoted in Lakatos, Worrall, and Currie, *Mathematics, Science and Epistemology*, 18.

55 Jeans, *The Mysterious Universe*, 17.

56 Russell, *On the Philosophy of Science*, 163. (Strictly speaking, causes are events, not things. Events occur, they do not exist.)

57 Quoted in Lenin, *Materialism and Empirio-Criticism*, 269.

58 Bohm, *Causality and Chance in Modern Physics*, 135.

59 Ibid., 20.

60 Ibid., 32.

61 Weinberg, *An Introduction to General Systems Thinking*, 232.

62 Bohm, *Causality and Chance in Modern Physics*, 3.

63 Planck, *Where Is Science Going?* 82–3.

64 Weinberg, *An Introduction to General Systems Thinking*, 105.

65 Elsasser, *Atom and Organism*, 89.

66 Ibid., 78.

67 Collingwood, *The Idea of Nature*, 123–24.

68 Cassirer, *Determinism and Indeterminism in Modern Physics,* 65.

69 Reichenbach, *The Rise of Scientific Philosophy*, 183.

70 Fast, *Entropy*, 174.

71 Kolata, "Catastrophe Theory;" Scheck, *Mechanics*.

72 Henderson, *The Fitness of the Environment*, 304.

73 Blandshard, "The Case for Determinism," 9.

74 Honig, "Mathematics in Physical Science," 361-62.

75 Edmonds, "Can a World without Infinity Be Compatible with the Real Numbers?" 79-83.

76 Blandshard, "The Case for Determinism," 9.

77 Reichenbach, *The Rise of Scientific Philosophy*, 200.

78 Bronowski, *A Sense of the Future*, 291.

79 Sagan, *The Cosmic Connection*, 43.

80 *Webster's New Collegiate Dictionary*.

81 Zipf, *Human Behavior and the Principle of Least Effort*.

82 Dudley, "Is There an Ether?" 41.

83 Hegel, *Natural Law*.

84 Gregory, *Scientific Materialism,* 157.
85 Collingwood, *The Idea of Nature*, 23, 167.
86 Gregory, *Scientific Materialism*, 107.
87 Büchner, *Force and Matter*, 30.
88 Houlgate, *The Hegel Reader*, 270.
89 Engels, *Dialectics of Nature*, 70.
90 Rosnay, *The Macroscope*, 80.
91 Cornforth, *Materialism and the Dialectical Method*, 41.
92 Bryen, *The Application of Cybernetic Analysis to the Study of International Politics*, 6.
93 Conger, *New Views of Evolution*, 193.
94 Deutsch, *The Nerves of Government*, 30.
95 Kwok, *Scientism in Chinese Thought*, 66-7.
96 Fleming, Introduction to *The Mechanistic Conception of Life*, xxvi.
97 Cassirer, *Determinism and Indeterminism in Modern Physics*, 140.
98 Cohen, "Toward Absolute Zero," 755.
99 Cairns-Smith, *The Life Puzzle*, 70.
100 Cohen, "Toward Absolute Zero," 752.
101 Lewis and Randall, *Thermodynamics and the Free Energy of Chemical Substances*, 448;———. *Thermodynamics*, 130.
102 Lewis and Randall, *Thermodynamics and the Free Energy of Chemical Substances*, 461.
103 Blum, *Time's Arrow and Evolution*, 2.
104 Whyte, *The Universe of Experience*, 53.
105 Wood and Fraser, *Elementary Thermodynamics for Geologists*, 38.
106 Hawkins, "The Thermodynamics of Purpose," 108.
107 Proctor, "Negative Absolute Temperatures."
108 Ibid., 99.
109 Whyte, *The Universe of Experience*, 69.
110 Daniels and Alberty, *Physical Chemistry*, 36.
111 Nicolis and Prigogine, *Self-Organization in Nonequilibrium Systems*, 24.
112 Hoffman, *The Concept of Energy*.
113 Cosmogonists are cosmologists who assume that the universe had a beginning.
114 Gamow, "The Evolutionary Universe," 18.
115 Rosnay, *The Macroscope*, 161.
116 Nagel, *The Structure of Science*, 425.
117 Ibid., 192-96.
118 Cassirer, *Determinism and Indeterminism in Modern Physics*, 125.

[119] Bohm, *Causality and Chance in Modern Physics*, 1.

[120] Scott, "Not (Just) in Kansas Anymore."

[121] Abell and Singer, *Science and the Paranormal*; Singer and Benassi, "Occult Beliefs."

[122] Singer and Benassi, "Occult Beliefs," 49.

[123] Ibid., 54.

[124] Hansel, *ESP*.

[125] Randi, "Geller a Fake, Says Ex-Manager."

[126] Fraknoi, "Astrology Put to the Test";———. "Further Tests of Astrology."

[127] Saltus, "Psychic Snooper Gets the Goods on 'Miracle' Workers."

[128] Stein, "Prayer Doesn't Aid Recovery, Study Finds."

[129] Capra, *The Tao of Physics*.

[130] Daniels and Alberty, *Physical Chemistry*, 36.

[131] Gillispie, *Genesis and Geology*.

[132] Miller, *The Old Red Sandstone*, 41.

[133] Eiseley, *Darwin's Century*.

[134] Field, "Poll Shows State Favors Teaching of Evolution."

[135] Kitcher, *Abusing Science*; Scott, "Not (Just) in Kansas Anymore"; Pigliucci, *Denying Evolution*.

[136] Numbers, *Creation by Natural Law*.

[137] Ibid., 88.

[138] Ibid.

[139] Ross, *The Creator and the Cosmos*.

[140] Kurtz, *Science and Religion: Are They Compatible?*

[141] Strom and Strom, "The Evolution of Disk Galaxies."

[142] Cherfas, "Evolution: Survival of the Creationists."

[143] Whyte, *The Universe of Experience*, 47.

[144] Schroedinger, *What Is Life?*; Whyte, *The Universe of Experience*; Makridakis, "The Second Law of Systems"; Nicolis and Prigogine, *Self-Organization in Nonequilibrium Systems*; Prigogine, "Time, Structure, and Fluctuations."

[145] Rifkin, *Entropy*, 6.

[146] Ibid.

[147] Weinberg, *An Introduction to General Systems Thinking*, 63.

[148] Schroedinger, *What Is Life?*

[149] Whyte, *The Universe of Experience*.

[150] Makridakis, "The Second Law of Systems."

[151] Nicolis and Prigogine, *Self-Organization in Nonequilibrium Systems*; Prigogine, "Time, Structure, and Fluctuations."

152 Schroedinger, *What Is Life?*

153 Whyte, *The Universe of Experience*.

154 Ibid., 42.

155 Ibid.

156 Ibid.

157 Makridakis, "The Second Law of Systems."

158 Prigogine, "Time, Structure, and Fluctuations"; Nicolis and Prigogine, *Self-Organization in Nonequilibrium Systems*; see also: Procaccia and Ross, "The 1977 Nobel Prize in Chemistry."

159 Onsager, "Reciprocal Relations in Irreversible Processes. I."

160 Nagel, *The Structure of Science*, 158.

161 Tribus, "Entropy," 239.

162 Shannon, "A Mathematical Theory of Communication."

163 For those who might enjoy it, I include the mathematical formulation of *complementarity*:

In mathematical terms the SLT is:

$$dS > dQ/T \qquad (3\text{-}2)$$

Where:

- dS = change in entropy of the system
- dQ = change in motion within the system
- T = temperature, degrees Kelvin

By symmetry, the complement to the SLT is:

$$dZ > dO/T \qquad (3\text{-}3)$$

Where:

- dZ = change in entropy of the environment
- dO = change in motion within the environment

164 Santayana, *The Realm of Matter*, 83.

165 Coe, "The Nature of Time."

166 Conger, *Synoptic Naturalism*, 197.

167 Cassirer, *Determinism and Indeterminism in Modern Physics*, 80.

168 Toulmin, "The Discovery of Time"; Toulmin and Goodfield, *The Discovery of Time*.

169 Toulmin, "The Discovery of Time," 100.

170 Hutton, "The System of the Earth, Its Duration, and Stability."

[171] Darwin, *The Origin of Species*.
[172] Marx, *Capital*.
[173] Mendoza, *Reflections*.
[174] Lewis and Randall, *Thermodynamics and the Free Energy of Chemical Substances*, 110.
[175] Rifkin, *Entropy*.
[176] Lewis and Randall, *Thermodynamics and the Free Energy of Chemical Substances*, 112.
[177] Elliot, *Modern Science and Materialism*, 61.
[178] Cassirer, *Determinism and Indeterminism in Modern Physics*, 58.
[179] Santayana, *The Realm of Matter*, 110.
[180] Planck, *Where Is Science Going?* 185.
[181] Ibid., 189.
[182] Thornes and Brunsden, *Geomorphology and Time*, 2.
[183] Rosnay, *The Macroscope*, 162.
[184] Prigogine, "Time, Structure, and Fluctuations," 785.
[185] Blum, *Time's Arrow and Evolution*, 109.
[186] Gardner, "Can Time Go Backward?"; Rosnay, *The Macroscope*, 168; Laszlo, *The Systems View of the World*, 52.
[187] Thornes and Brunsden, *Geomorphology and Time*, 2.
[188] Ibid., 140.
[189] Hawkins, *A Causal Interpretation of Probability*, 174.
[190] Santayana, *The Realm of Matter*, 109.
[191] Thornes and Brunsden, *Geomorphology and Time*, 2.
[192] Minkowski, "Space and Time."
[193] Barnett, Muehry, and Quinn, *The Charm of Strange Quarks*.
[194] Dobzhansky, *Mankind Evolving*, 25.
[195] Parsons, *Marx and Engels on Ecology*, 5.
[196] Perl, "Leptons—What Are They?" 564.
[197] Weisskopf, "Contemporary Frontiers in Physics," 243.
[198] Lakatos, Worrall, and Currie, *Mathematics, Science and Epistemology*, 123.
[199] Gamow, *The Creation of the Universe*.
[200] Planck, *Where Is Science Going?* 189.
[201] Davies, "Infinite Problems of the Very Small," 286.
[202] Edmonds, "Can a World without Infinity Be Compatible with the Real Numbers?" 83.
[203] Steen, "A New Perspective on Infinity."
[204] Ibid., 450.

205 Collingwood, *The Idea of Nature*, 156.

206 Ibid., 155.

207 Conger, *New Views of Evolution*, 9.

208 Borchardt, "Geochemical Similarity Analysis";———. "The SIMAN Coefficient for Similarity Analysis."

209 Borchardt, "The SIMAN Coefficient for Similarity Analysis."

210 Planck, *Where Is Science Going?* 49.

211 Bohm, *Causality and Chance in Modern Physics*, 157.

212 Ibid.

213 Weisskopf, "Contemporary Frontiers in Physics," 243.

214 Nagel, *The Structure of Science*, 66.

215 Rosnay, *The Macroscope*, 161.

216 Konstantinov et al., *The Fundamentals of Marxist-Leninist Philosophy*, 94.

217 Operationalists believe that all theoretical terms in science must be defined only by their procedures or operations.

218 Bohm, *Causality and Chance in Modern Physics*, 143.

219 Commoner, *The Closing Circle*, 33.

220 Quoted in Planck, *Where Is Science Going?* 119.

221 Weinberg, *An Introduction to General Systems Thinking*, 149.

222 Lewis and Randall, *Thermodynamics and the Free Energy of Chemical Substances*, 186.

223 Hawkins, "The Thermodynamics of Purpose," 107.

224 Bohm, *Causality and Chance in Modern Physics*, 81.

225 Science News, "More and More Mass."

226 The belief that light is a particle traveling through empty space.

227 Dudley, "Is There an Ether?";———. "The Neutrino Sea—Hypothesis or Reality?"; Ruderfer, "Neutrino Structure of the Ether."

228 Whittaker, *A History of the Theories of Aether and Electricity: The Classical Theories*;———. *A History of the Theories of Aether and Electricity: The Modern Theories*.

229 Munera, "Michelson-Morley Experiments Revisited"; Galaev, "The Measuring of Ether-Drift."

230 Einstein, "On the Electrodynamics of Moving Bodies."

231 ———. "Die Planck'sche Theorie Der Strahlung Und Die Theorie Der Spezifischen Wärme."

232 ———. *The Meaning of Relativity*.

233 ———. and Infeld, *The Evolution of Physics*.

234 ———. *Relativity*.

[235] Boehme quoted in Conger, *Theories of Macrocosms and Microcosms in the History of Philosophy*, 64.
[236] Samuelson, *Economics*, 9.
[237] Conger, *Theories of Macrocosms and Microcosms.*
[238] Althusser, *Essays in Self-Criticism*, 182.
[239] Conger, *Theories of Macrocosms and Microcosms*;———. *New Views of Evolution.*;———. *Synoptic Naturalism.*
[240] Ibid.
[241] Bohm, *Causality and Chance in Modern Physics*, 146.
[242] I thank Elizabeth Patelke for her help in devising this term.
[243] Ibid., 168.
[244] Ibid., 15.
[245] Whyte, *The Universe of Experience*, 80.
[246] Santayana, *The Realm of Matter*, 84.
[247] Christiaan Huygens in Dolling, Gianelli, and Statil, eds. *The Tests of Time, 169.*
[248] Hrachovec, "Human Life Extension," 139.
[249] Gould, "Sociobiology," 533.
[250] Margolis, *Persons and Minds.*
[251] Einstein, *Ideas and Opinions*, 232.
[252] Nagel, *The Structure of Science*, 158.
[253] Ibid., 186.
[254] Ibid., 158.
[255] Ibid.
[256] Lewis, and Randall, *Thermodynamics and the Free Energy of Chemical Substances*, 48–50.
[257] Maupertuis, *Essai De Cosmologie.*
[258] Zipf, *Human Behavior and the Principle of Least Effort*;———. "The Unity of Nature, Least Action, and Natural Social Science."
[259] Henderson, *The Fitness of the Environment.*
[260] Locker, *Biogenesis, Evolution, Homeostasis*, 101.
[261] Haeckel, *The Riddle of the Universe*, 184.
[262] Whitehead, *Science and the Modern World*, 180.
[263] Teilhard de Chardin, *The Phenomenon of Man*, 200
[264] Kellog, quoted in Velikovsky, *Earth in Upheaval*, 251.
[265] Darwin, *The Descent of Man.*
[266] Darwin, *The Origin of Species*, 88.
[267] Shklovskii and Sagan, *Intelligent Life in the Universe*, 244.

[268] Wade, "Sociobiology," 1153.
[269] Dawkins, *The Selfish Gene*.
[270] Mayr, "Biological Classification."
[271] Quoted in Carson, "Introduction to a Pivotal Subject," 1272.
[272] Lewin, "Biological Limits to Morality."
[273] May, "The Evolution of Ecological Systems," 161.
[274] Teilhard de Chardin, *The Phenomenon of Man*, 105.
[275] Ibid., 149.
[276] Ibid., 225.
[277] Ibid., 228.
[278] Hardin, Garrett, *Nature and Man's Fate*, 279.
[279] Shklovskii and Sagan, *Intelligent Life in the Universe*, 186.
[280] Calvin, *Chemical Evolution*, 251.
[281] Miller and Miller, *Evolution*.
[282] Whitehead, *Science and the Modern World*, 183.
[283] Velikovsky, *Earth in Upheaval*, 257.
[284] Ibid., 228.
[285] Shackleton and Opdyke, "Oxygen Isotope and Palaeomagnetic Stratigraphy."
[286] Burton, *Worlds Apart*, 139.
[287] Dott and Batten, *Evolution of the Earth*, 472.
[288] Riegel, *Energy, Life and Animal Organization*, 2.
[289] Ibid.
[290] Shklovskii and Sagan, *Intelligent Life in the Universe*, 244.
[291] Teilhard de Chardin, *The Phenomenon of Man*, 164.
[292] Hardin, *Nature and Man's Fate*, 71.
[293] Ibid., 82.
[294] Ibid., 92.
[295] Ibid., 67.
[296] Ibid., 286.
[297] Ibid., 297.
[298] Miller and Miller, *Evolution*, 43.
[299] Weinberg, *An Introduction to General Systems Thinking*, 214.
[300] Dowsett, "Probabilistic Models in Evolutionary Paleobiology," 654.
[301] This observation has universal application, not the least of which occurs in sociology.
[302] Haeckel, *The Riddle of the Universe*, 184.
[303] Teilhard de Chardin, *The Phenomenon of Man*.
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