

The Language of Nature

Steve Talbott

To judge from some of the ancient creation narratives, the world arose as a visible manifestation of speech. “In the beginning was the Word,” as it says in John 1:1. First there was formlessness and chaos, and then the divine voice flashed forth like lightning in the darkness. “And God said, Let there be light: and there was light.” The world began to assume visible, comprehensible form.

Whatever we may now think of the old visions of creation, we can remain sure of one thing: without the speaking of the Word—without language—we would have no science today with its striking power to illuminate the world. This observation may seem trite; no one will deny that we must use words in order to achieve and record our scientific understanding, or to pass it on to future generations. But once we stop to reflect upon the fact that science is always a science of speech, a remarkable thing begins to happen. We find ourselves transported to a richly expressive realm of scientific meaning, as far removed from cramped, conventional notions of science as the first day of creation was from the primeval chaos.

The truths capable of revolutionizing our understanding can sometimes be so close to us that we fail to notice them. So it is with science and language. It is not only that we humans happen to need words in order to talk scientifically about a world that in its own right has nothing to do with language. Rather, it is that our need for words testifies to the word-like nature of the world we are talking about.

We speak a word—say “atom,” or “energy,” or “mass”—and by this word we *mean* something. Of course, we readily acknowledge that the word itself has a meaning of some sort, but we should not forget that this meaning (to the degree we use the word truthfully) also exists in the world. After all, the whole point of our language, our speaking, is to characterize something other than the speech itself. We speak *about* something. We seek to elucidate an aspect of the world. To the extent the meaning of our scientific descriptions is not at the same time the meaning

Steve Talbott, a New Atlantis contributing editor, is a senior researcher at the Nature Institute and the editor of NetFuture, an online newsletter about technology and human responsibility (netfuture.org). He can be reached at stevet@oreilly.com.

WINTER 2007 ~ 41

of the world, the descriptions fail as science. As scientists we are always trying to speak faithfully the language of nature.

In slightly different terms: the world is in some sense a text waiting to be deciphered—which is why we can in fact decipher it into a scientific description. As with any text, we expect the world-text to make *sense*, to hold together conceptually, to speak consistently, to justify itself to our reason. These are demands we can bring only to whatever is word-like.

The intimate relation between the meaning of our words and the meaning we find in the world may be so obvious as to seem almost trivial, yet its implications are so profound as to have mostly escaped the notice of working scientists. If we took the fact of the world's speech seriously—the world *speaks!*—there would be none of the usual talk about a mechanistic and deterministic science, about a cold, soulless universe, or about an unavoidable conflict between science and the spirit. Confronting the many voices of nature, we would inquire about their individual qualities and character, we would look for the direction of their expressive striving, and we would struggle to grasp the aesthetic unity of their various utterances—all of which is to say: we would listen for their *meanings*. The necessity for such inquiry is implicit in a world that speaks and also in the scientist's employment of speech to translate the world-text. This turning a deaf ear to a resonant world and even to our own speech accounts, as we will see, for many of the limitations and contradictions of the science we have today.

As for what I mean by *speech* and *word-like*, I hope this will emerge with greater clarity over the course of this essay. Suffice it to say for now that everything word-like presents itself as a perceptible exterior bearing an inner and partly conceptual meaning. The meaning of words is never found in the mechanisms or physical causes of their production. No chemical analysis of the ink on the page, no physical analysis of the act of writing or of the speech apparatus and the air-forms it produces, can by itself give us the inner content of the words. That's because meanings and concepts are immaterial; they are not tangible or otherwise sense-perceptible things, which is what I mean by saying they are *inner*. One could also say: meanings are always contents or expressions of consciousness.

Most of us have had the experience of successfully reading the meaning of texts and hearing the meaning of speech, and therefore in this practical sense we already understand words as bearers of meaning. And just as we find our own speech vitally supplemented by physical gestures of every sort—gestures that are themselves outward bearers of inner meaning—so, too, all of nature presents us with word-like gestures. The

trouble, however, is that we often fail to pay attention; we never learn the language of the world we inhabit. We try to master nature while becoming increasingly deaf to her complex symphony.

The Evisceration of Meaning

Fish swim, and their capacity for swimming makes no sense without water. Birds fly; their entire structure and functioning testify to the sea of air in which they live. And we humans speak; we navigate a sea of meaning. As the bird and fish necessarily evolved in relation to their environment, so did we. Our speaking was made possible by the world's meaning. This meaning is no more an arbitrary and subjective invention of our own than the ocean is an arbitrary and subjective invention of the fish.

No one will deny that we *experience* meaning everywhere in nature. To sit in a quiet glade with the sun streaming through the trees; to endure the shattering power of a fierce thunderstorm; to enjoy the early green-ing of spring or the warm, rich colors of autumn; to stand beside a quiet pond or the rapids of a stream; to climb toward the summit of a high peak; to watch the unfolding drama of a sunset; to lie down and gaze up at the stars—every setting we encounter comes to its own meaningful expression within us. Everything speaks an inner language.

But our longstanding habit is to write this experience off as something wholly manufactured within ourselves—the speech, we are inclined to say, is our own, not nature's; it is subjective, not objective. And since whatever lacks objective value hardly seems worth bothering about in our quest for an understanding of nature, we have little incentive to attend to our experience of the stream or storm and even less to discipline this attention so as to discover scientific value in it. As a result, the experience really does fade into a kind of subjective vagueness, and increasingly we find ourselves drawing a slightly disturbing blank whenever we do try to appreciate the natural world in its own, qualitative terms. Jan Hendrik van den Berg presumably had something like this blank in mind when he wrote:

Many of the people who, on their traditional trip to the Alps, ecstatically gaze at the snow on the mountain tops and at the azure of the transparent distance, do so out of a sense of duty....It is simply not permissible to sigh at the vision of the great views and to wonder, for everyone to hear, whether it was really worth the trouble. And yet the question would be fully justified; all one has to do is see the sweating and sunburned crowd, after it has streamed out of the train or the bus, plunge with

resignation into the recommended beauty of the landscape to know that for a great many the trouble is greater than the enjoyment.

Few of us can altogether disclaim the experience of those tourists. Even many who are capable of more refined attention to nature will, I suspect, sympathize with my own plight: when I venture into the wild, something in me recognizes many “stunning” and “enchancing” things, and yet these things don’t speak to me with any clarity. I am continually drawn to them, sensing that they *should* speak to me with a force much greater than I am capable of receiving, but I am largely dispossessed of whatever understanding of their language humanity may once have had.

As for science, the problem of incomprehension seems to disappear only because nature’s speaking is more or less explicitly disavowed and therefore not attended to. One doesn’t even bother to get out of the bus. It’s enough to mount some instruments on the windows so that they can “observe” nature for us. This habit of inattention was asserted as a matter of principle almost from the beginning, when Galileo banned qualities from his science. Tastes, colors, and odors, he claimed, are “mere names” that “reside only in the consciousness.” External reality manifests nothing but shape, number, and movement, which, it happens, lend themselves to mathematical treatment. To rid science of qualities in this way, preferring mathematical demonstrations alone, was to push along the straightest path toward the elimination of meaning from science.

If nature is a speaking and science is one sort of translation of this speaking, then the decision to turn a qualitatively deaf ear to nature’s voice ought to be writ large in our scientific language. And so it is. In fact, language can show us with striking vividness the character of the blank that nature has become for us.

Empty Formalisms

In my primary school days it was still the common, if widely resented, practice for students to diagram sentences. The diagram offered a way to display as clearly as possible the grammatical structure of our language. Unlike most of my classmates, I loved this strange exercise. There was pleasure in grasping a relatively straightforward, unequivocal truth about words at the level of their structural arrangement. What I didn’t notice at the time was that in the act of tracing the diagrammatic structure of the sentences I was not attending in any full way to their meaning; all that mattered were certain structural relations between the words, not the meaning of the phrases and sentences themselves.

When you are diagramming sentences, the concrete and particular disappears into the abstract and general. The main thing you want to know about each word—such as “black” in “The large, black dog bit the postman in the leg”—is what grammatical category it belongs to. The meaning of the word scarcely matters; it could be “brown” or “fierce” or “crippled”—or even something senseless such as “prayerful” or “zodiacal”—and this would neither change the diagrammatic structure nor affect its correctness.

When we are diagramming a sentence, our understanding of it contracts into something precise and demonstrably correct, but our ease and precision of judgment is obtained by eviscerating the sentence of its full and particular content. Our attention is narrowed from the meaning of the words to a highly abstract feature of them. For example, all descriptive words of a certain sort become merely the same thing—“adjectives.” Words of another sort become nothing but “prepositions.” Once we have learned the rules for diagramming sentences, we can obtain correct diagrams almost while “running on automatic”; but the meaning of the diagrammed sentences—especially if they are at all profound—is far from automatically fathomable, and it would often be rather arrogant to say, “Here is *the correct* meaning of this sentence” in the way you might claim a correct diagram.

The operation of abstraction is perfectly legitimate and valuable in its place, but to forget what it removes from consideration—or that by itself it leads us progressively toward an emptying of meaning—is not helpful when we want to understand the words or, more importantly, the world the words are meant to illuminate. When we crucify the world-text upon a scaffold of grammatical logic, the resulting corpse presents its own fascinations, but these are not the fascinations of the original meaning; they are only a shadow of it.

On Being Wonderfully Precise About Practically Nothing

Diagramming sentences is only one of the ways we can reduce a full-fleshed text to a skeleton that we can nail down with greater exactitude. When we drive language as far as we can toward the pole of precision and definitive, yes-or-no certainty, we arrive at formalisms such as mathematics, grammar, and logic. In the case of pure logic, the withdrawal from meaning or content is so extreme that the logician conscientiously refuses to speak of the “truth” of his logical propositions. Instead he refers to their “validity”—their internal consistency without reference to any content of the world. And so Bertrand Russell, one of the preeminent logicians of the

twentieth century, once remarked of mathematical logic that it “may be defined as the subject in which we never know what we are talking about.” Einstein expressed a similar thought this way:

The skeptic will say: “It may well be true that this system of equations is reasonable from a logical standpoint. But this does not prove that it corresponds to nature.” You are right, dear skeptic. Experience alone can decide on truth.

Einstein also said this:

Pure logical thinking cannot yield us any knowledge of the empirical world; all knowledge of reality starts from experience and ends in it. Propositions arrived at by purely logical means are completely empty as regards reality.

Mathematics and logic as such are not about a *what*—not about the world’s actual and particular phenomena—but rather provide empty templates for thinking about the world in a certain way. *But we still have to do the thinking*, and we cannot bring the world into this thinking while remaining solely within the self-contained and reassuring purity of the templates. The world breaks every fixed template into which we try to pour it. Referring back to sentence diagrams: if we can substitute one adjective for another without affecting the correctness of our structure, then we have to acknowledge that the diagram fails us badly as an adequate explication of our speech; it cannot distinguish between any of our meanings. Words hopelessly overflow the expressive power of the diagram.

Despite the fact that purely mathematical thought and thought retaining observational content have very different character, they are intimately woven together by the scientist, even if the weaving does not often receive critical attention. This is both necessary and proper. But it is vital to understand the differing tendencies of the fabric’s warp and woof, and to recognize the unbalanced extreme to which the prevailing bias toward the quantitative and formal will lead us if it is not countered by something working at cross-purposes with it.

At least in the case of sentence diagrams we still have the meaningful text alongside the abstract grammatical structure indicated by the lines of the diagram. We can refer back to this text and relate our abstract construction to it at any time. We can re-enflesh the formal skeleton. Often in the “hardest” sciences the world-text—the phenomenon we began by trying to understand—disappears entirely behind multiple layers of

theoretical construction: formulas, equations, algorithms, and so on. Not only are the mathematical threads in our tapestry of cognition by far the most highly regarded, but “observation” has come increasingly to consist of the gathering of quantitative *data*, so that our tapestry begins to look like all warp and no woof.

In the modern age, this scientific approach to reality colors virtually everyone’s experience of the world, both scientists and non-scientists. Is it any wonder that van den Berg’s tourists should draw an unhappy blank when gazing upon the Alps? We have learned through long habit to discount the speaking content of nature as a vagary of each individual’s detached consciousness, superfluous in relation to the mathematical grammar that, we are sure, must be the potent, if incomprehensible, essence of what lies all around us. Or, alternatively, we feed on feelings awakened by nature, yet feelings that are uninstructed by any disciplined grasp of what nature is really saying.

It would be healthier if we could begin questioning our scientific inheritance without losing ourselves in romanticism. It is hardly impertinent to point out that if, in the interest of precision, we narrow our technical language down to an empty formalism, then we are not *discovering* the world to be meaningless; we are *insisting* that it be meaningless. There can be discomfort and threat in any confrontation with a speaking presence, and perhaps we should open ourselves to the possibility that much of our satisfaction in the unqualified rigor and precision of our science is really the satisfaction of curling up within the secure refuge of speechless quantity and logic, without having to venture too far out into the complex, soul-gripping presentations of the phenomenal world.

Minor Refinements or Wholesale Revision?

The conflict between the official banishment of qualitative language from hard science on the one hand, and the inevitable reliance upon it on the other, has led to a strange sort of schizophrenia. Physicists today employ mathematical constructions so neatly cohering and so universal in their logical coverage that some researchers, such as string theorist Brian Greene, have wondered aloud whether they are closing in on a finished “theory of everything,” while others have publicly debated “the end of science.” Yet many of these same physicists are driven by their work toward a kind of rootless, unrestrained, almost childish speculation about the nature of things. I will offer illustrations in a moment. But to see what is going on here, first consider a familiar case.

At a time when scientists were learning to observe and measure very high velocities, Einstein was led to the startling and unexpected theory of relativity. But if, in a scientific gathering today, you were to cite this theory as an example of the susceptibility of science to wholesale and fundamental revision, you can be sure that some of your listeners would respond by saying: “Einstein did not prove Newton’s prevailing formulas to be wrong; he merely showed them to be approximations in need of further refinement—extremely minor refinement under those conditions Newton was able to survey. Relativity did not so much negate Newton as confirm his results and extend them to cover more extreme conditions. The ‘correction’ is trivial under most normal circumstances.”

And this is true! At least, it remains true as long as we reside within the narrow, quantitative terms of our scientific laws or “grammar of nature.” But this is to ignore what was in fact a revolution in our understanding. The revolution becomes apparent as soon as we try to hear the meanings that alone enable our grammatical refinements to speak of the world. Physicist David Bohm reminds us that

while the laws of relativity and quantum theory do in fact lead under special conditions to small corrections to those of Newtonian mechanics, they lead more generally, as is well known, to qualitatively new results of enormous significance, results that are not contained in Newtonian mechanics at all.

Likewise, referring to relativistic effects upon mass, the late physicist Richard Feynman writes:

philosophically we are completely wrong with the approximate laws [such as Newton’s]. Our entire picture of the world has to be altered even though the mass changes only by a little bit. (Emphasis in original.)

One wonders only why he says “philosophically” and not “scientifically.” Is science really incapable of giving us a “picture of the world,” so that this picture must be left to the philosophers? In any case, if we want to understand the *world*, and not merely define more accurately certain regularities of its grammar, then we must grant that Einstein’s was an altogether different world from Newton’s, requiring a new way of conceiving the fundamental elements of space and time. To say that the changes Einstein introduced to our scientific understanding were “minor” is like taking the sentence, “The large, black dog bit the postman in the leg,” changing “black” to “invisible,” and then asserting that the change

in the sentence is minor—or indeed nonexistent, since the diagrammatic structure remains the same.

A science that can deceive itself in this way is a science that can all too easily say, “Our knowledge leaves no room for the human ‘soul’ or ‘spirit.’” And it’s true that the identification of science with empty formal structure leaves no room for soul and spirit. But it leaves no room for anything else, either. One can agree only with the first half of Nobel Prize-winning physicist Steven Weinberg’s remark in *Dreams of a Final Theory*:

The reductionist worldview *is* chilling and impersonal. It has to be accepted as it is, not because we like it, but because that is the way the world works.

Weinberg should rather have said, “because that is the way my preferred language works—the only language I wish to accept as scientific.” This language can seem chilling and impersonal only because it has been reduced to a grammar that necessarily ignores whatever understanding we might gain of the world’s meaningful content.

Deep Math and High Speculation

Once you have sacrificed meaning in order to arrive at your well-behaved grammatical abstractions, there is no way to recover the lost meaning from the abstractions alone. This is why physicists today, despite sharing an admirably exact mathematical grasp of the “fundamental laws of the universe,” give us the most amazingly different worlds when they try to imagine the reality from which these laws were abstracted—the reality that actually embodies the laws and lends them meaning.

So it is that the magazine *Scientific American* can advertise one of its publications by asking, “Is there a copy of you in another universe, reading this sentence?” And, we are assured, “the most popular cosmological model today suggests that the answer is yes.” The advertisement goes on, however, to note that physicists disagree in how they understand this notion of parallel universes, with some seeing the different realms as “wildly dissimilar,” displaying wholly different laws, and others seeing them as near-copies of each other. Such speculation leads the *Scientific American* copy-writer in the familiar direction taken by so many scientists when they try to explain themselves to a popular audience—namely, toward language that is almost mystical. There is, so we are told, “another possible plane of reality (one where you are most definitely not alone).”

Don't feel bad if you're mystified about this other plane of reality; so, it seems, are the scientists who sell books by employing such language. Their divergent speculations would make the most levitated medieval metaphysician blush. These speculations go far beyond parallel universes and tend to arise whenever researchers try to explain what sort of world their equations are about. Are nature's laws founded upon absolute randomness? Can time flow backward? Are there wormholes that take a shortcut through spacetime, linking two different places and times? Is there a shadow universe sharing gravity, but no other forces, with our own universe? Can we know the "real" world at all? Does observation create reality? Does consciousness create reality?

The ground under our feet becomes even less stable when we consider how even the most basic terms of routine scientific explanation are more or less blank. It was no high confession, but a simple recognition of the obvious, when Feynman remarked that "we have no knowledge of what energy *is*." Much the same is true of all the basic terms of science referring to the phenomenal world: gravity, light, heat, space, time, and so on. The language and methods of physics simply don't aim at discovering a meaning or content for these terms or for the realities that the words are supposed to express.

The theory of everything, it seems, comes perilously close to being a theory of nothing, or, at least, nothing very meaningfully understood—exactly what you'd expect when the theory's glory and substance are taken to lie in its purely grammatical or formal lawfulness. If the physicist's speculations about the nature of the universe sometimes seem bizarrely untethered, it's because *there is not enough reality in the "parameters" of this science to constrain interpretation*. This is just one example of the general fact that there is not enough reality in a formal grammar, or in a formalism of any sort, to constrain our understanding of the content expressing itself through the formalism. If we employ a reduced scientific language inadequate to express the world's reality, we will have a science with fantastic and unstable content reflecting undisciplined fancy more than reality. And this science, dominated in its meaningful aspects by untethered human fancy, is the same science, so we are continually told, that has displaced the human being from his cherished place at the center of the world.

On Perceiving the World as a Machine

There is, however, one reality principle in the hard sciences, and it rules with a vengeance. It is found in the uncompromising (and perfectly

healthy, in its place) demand for devices that actually work. What the researcher proposes does not become a part of science until it leads to an experimental apparatus that suffers predictable change under a specified set of circumstances. This technological imperative, with its useful and striking consequences for our daily life, accounts for much of the popular conviction that science *must* have succeeded in connecting us to reality.

And so it must in one way or another. Our science brings us very real manipulative skills. But the skills enabling us to manipulate a thing are not necessarily the skills yielding deep insight into its nature. In fact, in a world of speech and expression (consider your relations to family and friends), manipulation tends to work directly against understanding. In concerning ourselves with the mechanistic logic we can lay bare in an object, we are throwing a veil over its distinctive expressive character. The following reflection may help to clarify the point.

If you wanted to create a manageable, bounded, relatively self-contained realm embodying your conviction that the world is driven and controlled by a kind of formal necessity—by a pure structure of logic—you could hardly do better than to invent the computer. The entire history of technology has converged upon this apotheosis of mechanistic thought, often referred to as a “logic machine.” Strikingly, the machine’s program logic is now taken to *be* the machine, or at least to be what really counts in it. This is all too natural, given that, as Klaus-Peter Zauner and Ehud Shapiro describe, “today’s computers have been designed to follow strictly a formalism imposed independent of their physical implementation. The properties of the materials that implement the computation are hidden by careful engineering.” And so the same, high-level computational behavior can be designed into devices of radically, almost unrecognizably, different physical natures. This physical nature begins to seem irrelevant. It is not for nothing that computer scientists, preoccupied with their pristine algorithmic structures, often refer disparagingly to the clumsy and recalcitrant “world of atoms” in contrast to the light, lucid, and manageable “world of logical bits.”

This machine, with its externally imposed formal purity unsullied by the peculiarities of its material embodiment, a machine whose admired logic gives us virtually no understanding of the physical device itself, has become our reigning model for understanding the physical world. We imagine the world’s lawfulness to stand in the same relation to the phenomenal world as software stands in relation to the computer.

Along this path the way is open for an ever more complete withdrawal from the world’s self-expression. Whatever the wonders we have produced

within the closed system of technology, they do not testify to the disciplining of our understanding by physical reality except in a highly impoverished way. The magic of the digital machine is that by squinting at it in just the right way, we can drop the material device from view altogether and see only the clean, universal, eternal pattern of lawfully articulated logical bits that we ourselves have impressed upon the machine. This logic certainly does not picture for us the inherent lawfulness of copper, silicon, glass, and all the rest. Despite this, we are ever more inclined to view the natural world through the mental grid (or chain-link fence) constituted by our logic-machine ideal, and we thereby reinforce our impossible desire for a universal grammar of nature that somehow explains and determines everything that happens.

Of course, it requires only a little spilled coffee to remind us that the materials of the computer have their own substance and presence and sometimes maddening behavior not at all accounted for by the light and lucid “governing” laws we have programmed into their physical structure.

Toward a Primitive Animism?

The displacement of meaning by our grammatical fixation helps us to understand the curious ambiguity in our modern sense of alienation from the world. On the one hand, we imagine a kind of ironclad necessity imposed by universal physical laws. But because these laws are helpless to determine the world’s actual content, we do not in fact suffer from a sense of deterministic enslavement. Almost the opposite: the typical human complaint in the scientific era has been one of *meaninglessness*, which is a kind of hopeless non-determinism. The scientific account of the world lacks enough *significant* order, enough pattern and coherence of the speaking sort, enough sense and intention—in sum, enough textual meaning—to provide a context for our own meaningful existence. The problem is not so much that we are cogs in some inexorable machine suborning us to its own purposes, as that our science would allow this machine no purpose at all. And so we become lost atoms moving senselessly in the void. We are not predetermined but undetermined, not fixed but aimless.

Steven Weinberg gives unwitting expression to the complex nature of our alienation when he writes that we are the “more-or-less farcical outcome of a chain of accidents reaching back to the first three minutes [after the Big Bang],” and that we are “all just a tiny part of an overwhelmingly hostile universe....The more the universe seems comprehensible, the more it also seems pointless.”

Yes, the more we reduce our comprehension of the universe to a mere grammar, the more it seems pointless. But we can't really have a purely grammatical—an altogether empty or pointless—understanding of anything; we cannot have understanding without a content that somehow speaks. When we try, we end up supplying our own content, however crude and unrecognized. This is why Weinberg, despite his belief in an explanatory lawfulness utterly devoid of meaning, naïvely ensouls this lawfulness with his own meaning: the universe by his account is *farcical* and *hostile*—which is a far cry from being pointless.

Because Weinberg is not actually *looking* at the world's expressive qualities, his assumptions about their character are little more than a kind of animism in scientific dress; his inhospitable animating spirits of farce and hostility reek more of sour professor than of genuine demon. As for those who do look at the world, they may see elements of farce or hostility in limited contexts, but they certainly see a great deal more.

II.

The emptiness of scientific language, just so far as it fulfills the reigning quantitative and logical ideal, is scarcely open to dispute. It has been recognized, as we have seen, by prominent scientists and philosophers. If you still want to declare the world cold and impersonal, indifferent to human hopes and feelings, relentless and implacable in its mindless obedience to physical necessity—well, that is certainly your privilege. But the mathematical precision, certainty, determinacy, and universality of scientific laws is simply not an adequate or convincing ground for this contention. At least, it remains unavailable until one elucidates a path from empty formalism to a revelatory description of the world, and then demonstrates what the precision, certainty, determinacy, and universality of modern science mean for the enfleshed world. This in turn will require coming to terms with Einstein's now-familiar paradox: "As far as the propositions of mathematics refer to reality, they are not certain; as far as they are certain, they do not refer to reality."

Amazingly, this paradox has been little considered by working scientists, especially in the hard sciences. If, as embryologist Lewis Wolpert suggests, "all science aspires to be like physics, and physics aspires to be like mathematics," then, at the very least, we might want to inquire about the adequacy of our scientific aspirations. One physicist who at least refers to the problem is Richard Feynman. Alluding to the same theme we have

traced here, he reminds the mathematically inclined physicist of the necessity for a step beyond formalism toward real-world meaning:

Mathematicians are only dealing with the structure of reasoning, and they do not really care what they are talking about. They do not even need to *know* what they are talking about, or, as they themselves say, whether what they say is true.... But the physicist has meaning to all his phrases. That is a very important thing that a lot of people who come to physics by way of mathematics do not appreciate.... in physics you have to have an understanding of the connection of words with the real world. It is necessary at the end to translate what you have figured out into English, into the world, into the blocks of copper and glass that you are going to do the experiments with. (Emphasis in original.)

But this should not be taken simplistically. It cannot be merely a matter of translating from the language of pure mathematics to the meaning of the physicist because, as Feynman has just acknowledged, there is nothing we can say mathematics is *about*—no content available for translation. Before you can “translate what you have figured out,” you must have figured something out—something more than mathematical, having to do with the presence and character of an observable content. This content finds its way into our thinking by processes distinct from the abstract ruminations of the pure mathematician. The mathematics derives from the content, not the other way around. A formalism itself cannot direct us to any specific content capable of embodying the formalism.

How then *do* we find the content of our science? The ease with which this question has been ignored stands as one of the most stunning features of our science-committed culture. Science historian E. J. Dijksterhuis, describing the shift away from medieval thought during the scientific revolution, tells us that “‘substantial’ thinking, which inquired about the true nature of things, had to be exchanged for ‘functional’ thinking, which wanted to ascertain the behavior of things in their interdependence.” For this purpose, “the treatment of natural phenomena in words had to be abandoned in favor of a mathematical formulation of the relations observed between them.” Dijksterhuis seems to find nothing at all problematic or incomplete about this, as if we could possibly describe the relations between things without first understanding in words something about the things themselves.

Yet the fact is that we cannot even *see* a thing, let alone determine its relations, without taking it to be a certain *kind* of thing possessed of its own characteristic qualities. The question is only whether we will accept uncritically our half-conscious assumptions about the substantial nature

of things—as when, for example, we imagine subatomic particles to be very tiny bits of the qualitatively familiar stuff we deal with every day (an imagination that has caused no end of grief to physicists)—or whether we will instead raise these notions to full consciousness, where we can subject them to proper criticism.

To one degree or another, our science always does have real content, and whatever their disclaimers, scientists always do believe they have learned something about what Dijksterhuis dismisses as “the true nature of things.” And when we lay down our measuring instruments and let go of our high abstractions long enough to examine critically this meaningful content of our theorizing—when we try to understand the phenomena without which our mathematical formulations give us no knowledge of the world—then we find ourselves facing three closely interwoven aspects of the world as it becomes known to us: it is irreducibly *qualitative*; it is a manifestation of *consciousness*; and it is thoroughly *contextual*.

Qualities

Try sitting outdoors in a natural landscape for half an hour. After quieting yourself and becoming as receptive as possible to the surrounding world, consider this: Is there any content here beside the purely qualitative? From the sky and the distant hill to the grass, pine needles, or soil beneath your feet, do you not have to say, “The world I am experiencing simply *is* its qualities”? How many of us, during years or decades of creative work, will put such a problem to ourselves in this direct, observational, scientifically sanctioned way, as opposed to thinking *about* the problem in our studies or laboratories, with our thought mediated by a vast network of mental abstractions?

Now try subtracting from the content of your observation everything qualitative. In the case of the tree over there, remove the green of the foliage, the gray of the bark, the smell of sap, the rustling of leaves in the breeze, the felt hardness of the trunk . . . and what do you have left? Nothing at all. You do not even have geometric form, since without light and color there is no visible form, and without the different qualities of touch there is no felt form. Form is not something independent that we proceed to flesh out with qualities; it subsists in nothing but the qualities themselves.

You may want to say that the quantities we abstract from our qualitative experience of the world point us toward a more substantial reality hidden behind the world of our perceptions. But unless you can say something about this hidden reality—unless you can characterize it, giving your quan-

titative constructions some sort of content—where is your science? And how will you characterize this content without appealing to qualities?

Perhaps these qualities are the world's native way of presenting itself—not a terribly strange hypothesis, given that we cannot imagine any other manner of presentation. A true scientist would investigate the qualitative world in its own terms. These terms are not particularly obscure; they simply refuse to conform to our preferred scientific stance. An elementary quality such as red proves maddeningly elusive when our aim is to pin it down. My red shirt turns out to be a different color depending on the lighting and on the other colors around it, as well as on the state of my own eyes. Similarly with the qualitative nature of an entire complex organism: we recognize a *single* species-nature in a lowland spruce tree and an alpine one, but this common nature comes to dramatically *different* expression in the two cases. So qualities exhibit the one feature the logician must not tolerate: no quality is “just what it is and not something else.” Qualities interpenetrate one another, manifesting themselves differently in every different context.

Since qualities lack the sharp-edged, yes-or-no, unambiguous character of logic, the question to ask about any qualitative description of a phenomenon is not so much the simplistic “Is this precisely true (yes or no)?” as the more challenging “How fully and in what way does it reveal what speaks in the phenomenon?” Serious qualitative descriptions are never merely true or false; rather, they exhibit more or less expressive depth. They give us a more or less satisfying, a more or less penetrating, insight into (and feel for) what a phenomenon is *like*. When we are reckoning with qualities, questions of similarity are more central than questions of identity. It's one thing to record the contours of someone's face as a set of precise biometric spatial coordinates, and quite another to notice the distinctive *character* of the face. Often, however, we can read very little of this character in a frozen snapshot. That's because qualities are dynamic, not static. What they *are* is their inner movement, their manner of exchange and mutual interaction, so that we can catch them only in flight—by moving in a like manner along with them. They leave behind every effort to grasp them and pin them down. A sculptor of stone succeeds only by suggesting movement. Even in depicting a massive rock *as a rock* we must somehow capture a movement of profound rest, an ageless silence that is itself speech.

We can certainly learn to know qualities. However, our inner activity in taking into ourselves a particular quality involves much more than the play of abstractions over the surface convolutions of our brains. We can move with qualities only by acquiring some of the artist's sensitivity, with our mobile feelings and active will brought engagingly into play. We

experience qualities with our whole being, discovering, for example, that this color has something cool about it, that one something aggressive, and the other one something calming—characteristics of the sort that great artists have always had an ability to work with.

To look at the world with an openness to its qualities is to ask, “What kind of phenomenon meets me here? What is it expressing through the distinctive way it summons and coordinates the world’s lawful grammar? What melody of its own is this phenomenon picking out upon the mathematically tuned world-lyre?”

“Quality” is in fact an approximate synonym for “meaning.” But we usually speak of qualities when we are referring to the world, and we speak of meaning when we are referring to language and thought. The two usages are closely intertwined. The way we reduce the world to atomic *things without qualities* is by reducing our descriptive language to the atomic terms of *logic without meaning*. That is, we can obscure the qualitative character of the world only by obscuring the meaningful character of our words. But we never fully succeed in this. The world remains word-like because it is full of the meanings of language, just as our words remain world-like because they are full of the qualities of the world.

Consciousness

Everything we’ve noted about qualities points to the fact that they are expressions of consciousness. This is hardly controversial; the reason why the scientist fled qualities from the very beginning is that they “reside only in the consciousness” (Galileo). But given that the only “place” we have for experiencing and knowing the world is in consciousness, and given that we evidently do gain at least some real understanding of the world, it seems only reasonable to believe that our consciousness is well-suited for translating the language of nature. In the world, our consciousness meets something like its own activity, something akin to its own nature. With our wide-ranging potential for conscious experience, we are ourselves expressions of the cosmos. Is it surprising, then, that we should be able to give conscious expression to what speaks in the world?

In some scientific quarters, such a thought is seen as outrageous, while at the same time some of those most envied of scientists, the physicists, speak casually of consciousness as in one way or another fundamental to the cosmos. As Sir Arthur Eddington wrote in 1920:

[Our knowledge of physics] is only an empty shell—a form of symbols. It is a knowledge of structural form, and not knowledge of con-

tent. All through the physical world runs that unknown content, which must surely be the stuff of our consciousness.

Presumably he means “unknown” only in terms of the accepted, one-sidedly quantitative ideals of science, for if there is one content we can know, at least to some degree, surely it is the content of our consciousness. Modern science is generally unwilling to admit of consciousness in its understanding of nature—an odd fact when you consider how many authorities in different fields loudly disavow the Cartesian diremption of matter from mind. The situation becomes more understandable only when we realize how thoroughly Cartesian these authorities remain: they take their stand firmly astride the fractured Cartesian bedrock, and then hope only to make one side of the divide disappear by reducing it to the terms of the other. A real solution will be found only when we go back and refuse the split altogether, finding another way forward. And this way will include the recognition that the world has a word-like character. Only in language do we find the marriage of inner and outer in a way that overcomes all the conundrums of the mind-body dichotomy. But appreciating this solution can require agonizingly hard work when you have been raised, as nearly everyone in our culture has, upon Cartesian habits of thought. (My own path away from these habits was blazed by the philologist and historian of meaning, Owen Barfield.)

The prevailing refusal to set aside our Cartesian blinders can hardly be disputed. When we analyze sound—whether of a volcano or a musical performance—solely in terms of air waves, our terms are, strangely enough, as fully available to a deaf person as to someone with good hearing (a point once made by the German physicist and educator, Martin Wagenschein). In fact, the ideal of rigor within the hard sciences generally aims, rather impossibly, for the use of terms understandable by someone who has no conscious perception of the world whatsoever. Such a person, if he actually existed, would have no world in need of understanding. If, however, we do have a world to understand, it is a world whose nature is to present itself within our consciousness.

Context

We gain a kind of unqualified crystalline clarity by filtering our perceptions of the world through a web of logically precise abstractions. Even space and time become, through analysis, a collection of discrete points or discrete instants of time. But the quantifiable crystalline clarity we thereby achieve belongs to our perceptual filter and not to the world. Dazzled by this clarity and fixity, we become blind to context.

Go out again into a natural setting, sit down, and spend a while taking in everything you can see, hear, feel, and smell. Then ask yourself: does this world, in any meaningful sense, consist of discrete points or instants of time?

You will be hard put to find any justification in observation for these abstract notions. The world and its events present themselves—stunningly, when you compare your actual experience to the various theoretical ways of thinking about the world—as one seamless whole. Points and instants flow into each other, participate in each other, and cannot be clearly separated from each other. Likewise, the seemingly incommensurable “data” of our sight and hearing, our smell and touch, yield moment by moment a single, unified image of the world. Pick any visible object—a tree, say—and try to isolate it cleanly and without ambiguity from everything around it. It cannot be done.

Again, this is hardly controversial. The entire discipline of ecology was founded upon the awareness that organisms are an expression of their environment, and the environment is an expression of its organisms. At the largest scale, the earth’s atmosphere, as it once existed, would have been poisonous to today’s living forms, and only through the influence of the evolving life forms themselves has it become what it now is. The earth’s breathing and that of its creatures is one breathing, and the organism meets itself in its environment.

But it is not only organisms that require a contextual understanding. Every entity, process, and law described by physics gains its real content only by means of its context. We may be able to discern *in* a process a certain quantitative lawfulness that is invariant from one context to another—because the quantities have had all context and phenomenal content stripped from them. But while this absolute sort of lawfulness may be abstractable from the physical process, the observable content itself is never invariant or subject to necessity in the way we take our universal laws to be. The reason we have to abstract the content away in order to arrive at the mathematical “explanations” is simply that the content of real events is not explained by the mathematics alone. In a beautiful meditation, physicist Georg Maier offers examples, some of them very simple, of the fact that the world’s material processes can be understood only contextually:

- “Warm air rises”—and so it does in a closed room, where you will find the air warmer near the ceiling than at the floor. But in the open atmosphere the air usually gets colder with height. You can understand the difference only by considering the two different contexts, one of which limits the upward movement of air, while the other does not.

- Gravity has very different effects, and must be described in different ways, depending on whether you are walking on the solid earth, “floating” in orbit around the earth, or swimming in a lake. The different effects extend even to the question of whether your bones will be subject to a dangerous loss of mass—something of concern to long-term inhabitants of orbiting space stations.

- If you place a lighted candle inside a jar and then accelerate the jar (along with its atmosphere and candle), you will find the flame leaning *forward* in the direction of acceleration, a behavior “contradicting” our more common experience with accelerated objects.

These examples will seem either trivial or profound, depending on our ability to discern the subtle distinction they require. The statement, “warm air rises,” refers to observable behavior in the world, and therefore, construed as a universally valid law, it fails. All you need to do is to change the context, and a different behavior results. This is true of any law presuming to specify, in unqualified terms, what real things will actually do. Such laws will be thoroughly contextual, so that in different contexts the phenomena will bring their lawfulness to a different expression. We overcome this contextuality only by retreating from a description of phenomena to a statement of “grammatical” regularity abstracted from all concrete and particular reference.

You can see the retreat in a law such as Newton’s universal law of gravitation, which is sometimes stated in this way:

Every particle of matter in the universe attracts every other particle with a force directly proportional to the product of the masses of the particles and inversely proportional to the square of the distance between them.

Here there is no longer an assertion about what any particular things will actually do (“warm air rises”), and this is why the law escapes falsification by different contexts. It doesn’t tell us about contexts; it is a decontextualized statement. The “attraction” it speaks of is not a specific, observable behavior of any sort—not, for example, a movement of objects toward each other—but a grammar that any actual movements will be found to respect. Real bodies moving according to this grammar may approach each other, spiral around each other, or move directly away from each other.

The actual behavior of things in the world is always an expression of context. What Maier says of a gas can be said of everything we encounter in nature: it “is so intimately entangled with its environment that its phe-

nomena can be accounted for only as part and parcel of a greater whole.” If we want a lawfulness bearing on such contexts, then we will have to look for—what else?—a contextualized sort of lawfulness. The coherence to expect is more like the coherence of a picture or image than of isolated entities. It is more like the coherence of a sentence in a story (which plays into and colors all the words around it) than the coherence of a logical proposition.

Qualities already imply context. This is because they refuse to be “just what they are and not something else,” but instead interpenetrate and share something of their identity with each other. Discrete, qualitatively featureless particles can exist only in nameless, side-by-side aggregation; they can never give us the kind of contextual unity that plays into, modifies, and binds together the various elements of the context. In order for there to be a true context, something must reach across and penetrate all the elements, shaping each of them to the character of the whole.

Nothing requires us to give up our useful inquiry into nature’s formal grammar. But the many conundrums into which this inquiry leads us—conundrums widely recognized whenever scientists temporarily extricate themselves from their dense mesh of theoretical abstractions, face nature herself, and try to understand what they have been talking about—will remain insuperable obstacles to progress until we can begin to explore what this new, contextual, and more imaginal form of understanding might require of us.

Reified Equations

Here we need to pause and consider the instinctive objection that almost inevitably arises at this point, rooted in stubbornly entrenched habits of thought: “It may be true that a universal law such as the law of gravitation cannot tell us everything that will happen, say, among the objects of the solar system. But that’s because there are other laws at work as well. If you add in all these other laws, then, at least in principle, you will understand everything that happens. What can you point to that escapes this all-encompassing lawfulness?”

The short answer is a simple reminder: I have not been suggesting that anything needs to violate the universal laws of physics—no more than a meaningful sentence needs to violate the rules of grammar. But the necessities of a sentence’s grammatical form are insufficient to determine what the sentence is saying—they do not give us its content—and neither do the formal necessities of mathematically stated laws give us the content

of the world. Where we have such content, it speaks forth its own coherent meaning, and while this meaning may always respect an underlying formal grammar, it can never be reduced to such a grammar.

But this short answer requires expansion. Think of the movements of the heavens, which perhaps are what most naturally come to mind when we imagine the determinism of physical law. Perfectly timed eclipses, precisely targeted space probes, the regular rhythms of day, month, and year—certainly these are real phenomena, and we commonly manage to predict them with extraordinary accuracy. Could any phenomena be more fully determined by mathematical law than these?

Well, again, the point is not that mathematical laws must be violated. Nor is it that there must be some element of randomness or wild, lawless disorder in the cosmos. Contextual coherence, after all, is not randomness and disorder. But neither can its significance be expressed in purely quantitative or formal terms. It is a different—a *meaningful*—kind of order.

When we think of the heavens as explained by the mathematics of the universal law of gravitation (and other laws), we have reduced sun, planets, and moons to anonymous point-masses whose “character” or “behavior” consists of nothing but their trajectories through space. These bodies have become in our minds little more than reifications of their governing equations. The distinctive nature of the bodies doing the movement has completely dropped from view. It’s as if on earth we looked around at people, muskrats, squash plants, clouds, boulders, and springs, and saw no challenge to understanding apart from calculating the diverse spatial trajectories of the objects.

You need only reflect upon all the scientific disciplines arising from our experience on earth to realize that, when we think of the moon or sun as mere points in motion, we have blocked from our view virtually all the reality of these bodies—all the reality we would have to account for if somehow we were adapted and sensitive to their alien conditions. If you ignore everything except points in motion—everything constituting the expressive reality of a phenomenon—then it is not the phenomenon you are describing. You are simply using an image (say, of the moon) as a token to stand in your imagination for the lawful grammar that, as we have already recognized, can be abstracted from the physical world.

Earlier generations spoke of various *influences* streaming in from the heavens, and of the humanly relevant *dispositions* of celestial bodies (or beings), and of the *lunatic* or *mercurial* nature of people or events, and of the heavens declaring the glory of God. If, after peeling away the layers of superstition accreted around such notions, we are to assess whatever

validity they may have had—or even if (which must come first) we are to understand what sort of thing the ancients might have meant by such thoughts—we will have to look beyond a mere grammar of movement and open ourselves to the world's qualities.

What Is a Force?

Even if we start with the words we commonly use in stating our most rigorously quantitative physical laws, and if we take these words as really meaning something, we are immediately carried toward a richly qualitative world. At mid-twentieth century the philosopher Kurt Riezler, speaking about the concept of force, chided physicists with these words: “You use the word ‘force’ and, when queried, you define it by law, field, and vector; but what you really have in mind is the force you feel in commanding your muscles.”

Can we gain an adequate scientific understanding of gravity except by referring to the willful use of our muscles or our experience of pressure? True, many scientists will react initially to the question by citing the purely objective relationships of moving masses—relationships given in strictly mathematical terms. But the word *relationship* here turns out to be rather pregnant. It conceals—so long as we are willing to avert our gaze—what *sort* of connection between things we really have in mind.

Objects changing their positions in space may give us certain mathematically describable relationships, but so, too, can points on a piece of graph paper. No one takes these points to be exerting a physical force upon each other. Neither could we think of planets as exerting a force upon each other *unless we had an independent concept of force*. As the graph paper illustrates, the mathematical relationships alone do not give us such a concept. Think about it all you wish, but a force is something real in the world, and you will never find a concept for it except through your own experience of the world.

This experience, like all our experience, occurs within consciousness. And it is an indication of the radical and unexplored possibilities of a qualitative science that we cannot say *a priori* that our conscious experience of bodily forces is completely unrelated to our experience of the “force” of a personality, the “force” of suggestion, or even that attractive power, or “force,” of love that some of the ancients imagined to be at work in the descent of heavy bodies toward the earth. Such possibilities may be crazy or not, but confirming or refuting them would require a kind of devotion to our experience of the world that we long ago lost interest in sustaining.

In any case, without *some* sort of experience of force within the inner domain of our own consciousness, we have no meaning for the scientific concept of force. Of course, the law of gravity is not meaningless, and we heard Riezler explain why: we can't help bringing our conscious experience to the law, even if this experience remains more or less unacknowledged and therefore is never subjected to proper scientific criticism.

To Explain or Portray?

In aesthetics and in the notion of “formal causation” tracing back to Aristotle, the *formal cause* of a phenomenon or work of art is its unifying shape or form. But this shape is not taken to be a mere distribution of mathematical points within a spatial grid; rather, it is the overall expressive gesture of the thing. This older conception of cause points us toward the qualitative form or meaningful patterns, the governing unity, according to which phenomena unfold rather as a spoken sentence progressively unfolds to express an antecedent governing idea—an idea that informs and transforms the individual words, shaping them to itself. This meaning of “formal,” of course, is nearly opposite to the “formal” and “formalism” I have been employing till now.

The usual notion of cause and effect in science can be understood as a more or less distant approximation of formal causation. Trying our best to isolate from their expressive context a very few things possessed of perfectly definable relations, we imagine a “closed system” immune to outside influences. We shift from imaginal thinking to abstraction, from recognition of qualitative expression and the mutual interpenetration of elements to the search for isolated, well-defined parts. Then we say: “This makes that happen” or “This condition leads exactly to that condition.”

While there can be no truly closed system, this exercise is useful as long as we realize we're dealing with approximations and that the more we approach an absolute precision and necessity in our cause and effect, the more we have abandoned the context with its expressive character, so that, in the end, nothing of any particular phenomenon remains. We redeem the approximations by realizing that they *are* approximations and by allowing them to clarify details which we then enliven by bringing them back into qualitative connection with the meaningful whole.

This is very much the way neurologist Kurt Goldstein approached the “mechanical reflex” in his several-decades-old and important book, *The Organism* (recently reprinted with a foreword by Oliver Sacks). Goldstein looked at the various ways we analyze organisms into rule-based, mechanical parts and then try to reconstruct the whole from these parts. It never

works. For example, he assesses the reflex in humans and animals, showing in exhaustive detail that the “simple-minded” reflex mechanisms we so easily imagine don’t really exist. For example, slight changes in the intensity of a stimulus can often reverse a reflex; a reflex in one part of a body can be altered by the position of other parts; an organism’s exposure to certain chemicals such as strychnine can reverse a reflex; other chemicals can completely change the nature of a reflex; fatigue can have the same effect; consciously trying to repress a reflex can accentuate it (try it with your “knee-jerk” reflex); and so on without end.

Goldstein showed that the reflex is an artifact of our own stance as researchers, whereby we conceptually and experimentally isolate one part of an organism, cutting the part off from its whole. Moreover, he finds that higher organisms, including human beings, are much *more* likely to show approximations of reflexes, because it is we who can allow parts of ourselves to become isolated and de-centered. (That’s what many procedures of medical assessment are all about.) As Goldstein describes:

Human beings are able, by assuming a special attitude, to surrender single parts of their organism to the environment for isolated reaction. Usually, this is the condition under which we examine a patient’s “reflexes.”...But [regarding the pupillary reflex] it certainly is not true that the same light intensity will produce the same contraction when it affects the organ in isolation (as in the reflex examination) and when it acts on the eye of the person who deliberately regards an object....one only needs to contrast the pupillary reaction of a man looking interestedly at a brightly illuminated object with the reaction of an eye that has been exposed “in isolation” to the same light intensity. The difference in pupillary reaction is immediately manifest.

In sum, we arrive at the law of the reflex only by isolating a separate part of the organism and confining our attention to this part in disregard of the whole. The only way we can achieve such isolation is by draining the context of its interpenetrating qualities, such as the quality of *interest* and the corresponding qualities of the eye in Goldstein’s example of the pupillary reflex. The fullness of reality fades away, leaving the kind of logical skeleton we so easily conceive as a mechanism, with its separate, well-defined parts.

This is to suggest that we can best understand exact, fully determining causes as the incompletely incarnated ghosts of formal causes. They are more or less ineffective when juxtaposed with the sinews and countenance of reality, and reveal their impotence when we try to make them account for this reality. Johann Wolfgang von Goethe was pointing

to this inadequacy of cause-and-effect explanation when he remarked of his pioneering morphological research that “its intention is to portray rather than explain.” Goethe’s idea seems to be that description—or at least description of the right sort—itsself constitutes understanding. This is implied more strongly in another of Goethe’s oft-repeated koans, which anticipates a great deal of modern thought: “Everything in the realm of fact is already theory....Let us not seek for something behind the phenomena—they themselves are the theory.”

It’s obvious enough that we cannot describe anything well without having a good understanding of it, and this understanding informs the description. Goethe’s sage advice sounds anemic only when we cannot let go of the misplaced hope that the world might be grasped and explained in the way a logical structure, once we have purged it of descriptive content, can be grasped and explained. This is to forget that logic helps us on our way toward understanding only when, in the very act of performing its clarifying function, it sacrifices itself to the expressive content from which we drew it out. This sacrifice is the reverse of that crucifixion of the world-text upon a scaffold of logic to which I referred earlier.

To prefer portrayal over explanation is to reject the *one-sided* (and never fully achievable) drive to isolate restricted contexts and precisely definable causes or laws. It is to refuse to lose sight of the interpenetration and mutual participation of things, even while accepting the necessity for narrowly focused excursions. It is to let go of explanation as something *fixed*, as something we can *have*, which easily becomes a dead weight upon further inquiry. A portrayal requires a stronger, more full-bodied inner activity on our part in order to hold everything together and grasp its coherence; the portraying is something we must *do*, not only with thought, but also with feeling and will. We have to trace the fluid, complex way in which one contextual *picture* metamorphoses into another instead of the vanishingly simplistic way in which isolated (and therefore impossible) things univocally affect other isolated and impossible things. We have to engage in this inner activity because it is the only way we can move harmoniously with the activity we encounter in the world; it is the only way we can truly understand the language of nature, which is at the same time the meaningful language of our own being.

III.

We are creatures of the word, inhabiting a world that can be understood only as speech or text—even if we prefer to notice only its blank,

unspeaking grammar. Our own communication depends upon the word-like character of the world; if we did not find word-stuff all around us, we would have no material for our own words. Nature presents us, not with blank, mute, disconnected objects, but with expressive *images*, and such images are the native elements of story, song, and poetry. Even at the level of “mere” sound we can say: only because every sound has its own gestural and significant form—only because it speaks with its own qualities—can we recognize it as a distinctive element and employ it for our own speech.

Further, even where we have reduced speech to the high abstraction of alphabetic text and have rendered the connection between word-signs and their meanings perfectly arbitrary, a speaking quality of the signs themselves is prerequisite to our apprehension of them as words. If we did not perceive and feel the different qualities of a horizontal and vertical stroke, and again of a vertical and circular stroke, we would be unable to distinguish one alphabetic character from another. This last point, humble as it may be, sums up everything I’ve been saying in this essay. It is also extremely difficult for people of our day to grasp, and is worth a great deal of reflection.

The Gestures of Life

If we were given a set of mathematical coordinates defining the pixels, or points, of a pen stroke, these coordinates would remain meaningless; we could not recognize them as any sort of unity or as any specific thing—not until, with the aid of our knowledge of coordinate systems, we pictured the points as constituting a significant form. What is hard to appreciate is that we cannot recognize anything except by recognizing it as a particular *kind* of thing, having some sort of apprehensible character. There is always an aesthetic judgment at work. We can distinguish a horizontal from a vertical line only because, in an objective and cognitive sense, we can *feel* the difference between them—we can experience the difference rather in the way we experience the difference between our own arm held first horizontal and then vertical, and in the way both actor and audience experience the dramatic contrast between an outstretched and an upraised arm; in every specific context they speak differently. The two gestures have different expressive potentials.

The natural world is nothing but such gesturing, even if at a vastly more profound level than our own gesturing—a level where the gesturing is at the same time a power of physical manifestation. We can know that something is there only so far as we find ourselves “gestured at” in a

recognizable way. It may be worthwhile to take a brief look at one or two of the countless “alphabetic strokes” of nature with which any qualitative science is likely to have to reckon. I will not speak here of any body of science, but merely of possible elements belonging to a language of scientific investigation.

Not so long ago, soon after awakening on a cool morning, I stepped out of my darkened home into the radiant and golden warmth of the newly risen sun. Having had nothing particular in mind, I was suddenly and unexpectedly moved by a feeling I can describe (inadequately) only as one of expansion—as if I were drawing a deep, inward breath and my arms were opening outward to embrace the fullness of the world. Not being one to live at all vividly in his perceptions, I was struck by the force of the sensation, and began to wonder whether it spoke in any objective way about the morning and sunrise. Was I experiencing a significant element in the language of nature, or just the incidental noise of my own body and psyche? Does nature speak forth the dawn of a new day in a unified language of aesthetic gesture? Is there, for example, any possible justification for the common sentiment that nature in some way *rejoices* in the dawn?

Over the following weeks I focused on a few simple gestures—for example, the expansive opening to the world I had experienced, and the ascending movement we see in the rising sun. And it proved useful to contrast these with more or less opposite movements.

However much I might have been inclined to dismiss my own sense of enlargement on meeting the sunrise, I could hardly dismiss the fact that *nature* was going through something analogous. In a literal, physical sense, nearly all substances—rocks, lakes, plants, the earth itself—expand under the heating effects of the sun, and they contract again as the environment cools at sundown. The atmosphere, too, dilates under the sun’s influence, which also sets in motion rising currents of air. We often see a morning mist rising from sun-lit ponds. And if there is a cloud type most characteristic of the day, surely it is the expanding, upward-billowing cumulus cloud. At night the cooling atmosphere “settles down,” and we may find a layer of fog pressing against the earth. Cyclonic storm systems, which tend to contract and lose intensity at night, begin to grow again in the morning.

Living things exhibit similar gestures. Perhaps most noticeably, many flowers and leaves open outward in the morning and close in upon themselves at night. In herbs and trees, the morning sun draws the sap upward; water, too, ascends from the roots, engorges the leaves, and then evaporates outward and upward into the atmosphere. We ourselves greet the day by stretching our whole beings: our chests swell and we extend our arms

toward the periphery as we prepare to meet the world again. At the moment when we awake and look out upon a sun-lit world, it is easy to experience how our psyche is transformed, gaining a certain outward-oriented solidity and spaciousness as we are enlarged by our surroundings.

And the sun itself? It *radiates*. Here I am not referring to the falsely imagined “rays” supposedly traced by particles of light. I am speaking of the *gesture* of light—a gesture we can perceive directly. At dusk, let your eyes rest for a while upon the darkness of a valley and wooded hillside, then raise your gaze to a remaining patch of light sky. Once you have learned to still your thoughts *about* what you are seeing and instead to use the perceptive capacities of your entire organism, you can experience the radiating gesture of this light—sometimes almost explosively. Light that is *too* bright strikes us so forcefully as to make us recoil and shield ourselves from injury.

I remember hearing people talk, earlier in my life, about the two different expressive characters of sunrise and sunset. At the time this struck me as misguided: “The two occurrences are exactly symmetrical, with the sun shining from one horizon or the other through the thickness of the atmosphere. The difference between east and west can hardly be crucial. You can have beautiful red sunrises just as you can have beautiful red sunsets. Where is any essential difference between them?”

This was unutterably foolish of me. I was thinking in terms of static snapshots, entirely forgetting their context. In reality the two events are polar opposites. Leaving aside the fact that the constitution of the morning atmosphere tends to differ considerably from that of the evening atmosphere (for example, there is typically more haze or dust in the evening), there remain the most obvious features: the morning sun is rising while the evening sun is setting; the day is brightening and warming, or else it is darkening and cooling.

Try a simple exercise. Stand upright with your arms at your side. With your consciousness as quiet as possible, attending only to the inner qualities of your movement, very slowly swing your arms in front of you, palms upward, as if you were following the rising sun with your hands. Then pause, turn your palms downward, and let your arms slowly perform the reverse movement, descending to the starting position. (You will be forgiven if you find something almost reverential in the exercise.) With any attention at all, it is not hard to experience the very different character of these two motions. With the one we easily feel (among many other things we might pay attention to) a sense of anticipation, of beginning, of active engagement, perhaps even of celebration. With the other there is a

calming, a coming to rest, a sense of completion—and perhaps, too, celebration, only now it is celebration of fulfillment more than expectation. At the very least, we have to say that a sunrise and sunset are as different as these two expressive movements.

It's important to avoid a kind of wooden oversimplification, as if we were dealing with fixed elements of logic rather than living gestures of the world. Every slightest alteration in the overall constellation of a gesture makes for a *different* gesture. In fact, it is impossible ever to perform exactly the same gesture twice. If, instead of asking you to let your arms descend directly in front of you as you followed the movement of a sunset, I had instead suggested that you position your arms a little more widely apart, perhaps bending them more at the elbow, then the restful and calming aspect of the gesture would have been accentuated. If I had told you to relax your arms completely, letting them fall limply under the influence of gravity, the descent would have spoken more of heaviness than of rest. And if I had asked you to hold your arms rigidly straight during the downward movement, with elbows locked, the sense of rest would largely have been lost.

The failure to recognize the multivalent potentials of every abstractly understood movement (“descent”)—and also of every other kind of gesture, such as that of a color or a sound—has resulted in a great deal of nonsense being written about the lack of any universal or objective language of qualities. Every gesture is concrete and contextualized, and therefore unique, but contextualization is not the same thing as arbitrariness. Anyone who has worked with gestures—such as the sculptor or painter—knows that he is working with a language not only of boundless expressive potential but also of great definiteness and consistency. While qualities are fluid and interpenetrating, modifying one another and lacking any fixed and static identity, they nevertheless have a vivid character that we can enter into and work with.

Clearly, whatever coherent “morning conversation” may take place among stone, flower, cloud, and the rising, radiating sun, the language of this conversation is not in any primary sense the language of universal physical laws. Whatever expressive unity may exist between the expansion of a stone and the opening of a flower, we cannot portray it merely by citing particular mechanical principles they happen to share. Yet the question remains: While speaking in the distinctive language of their particular substances and organization, are they contributing their own harmonies to an integral symphony of the morning we can recognize throughout nature?

Of course, if we attend only to mechanical principles, then the various gestures I have cited can never even occur to us as a challenge for our

understanding. Yet matters get more complicated—and more interesting—when we recognize that all our science is grounded, in one way or another, in our experience of just such gestures. Even the world’s basic materiality, grounding the scientific concept of mass, gains content for us only by virtue of a certain inner movement expressing something like denseness or compaction, and also resistance. Without this inner experience, we would have no content for the concept. It wouldn’t mean anything; we would not know how to go about exploring its mathematical grammar because we would have no “it” to guide our exploration.

Once we have recognized the real content of our scientific language, we can hardly turn away from the kind of question I am raising here, however unfamiliar it may seem. The question is not, “Do the stone and flower make expansive gestures under the influence of the sun?” This is simply given and cannot be doubted. Rather, the question is whether the collection of gestures I have cited can, when united with a great deal more understanding of morning and evening contexts, speak in a coherent, aesthetically unified way.

This is not a simple or obvious matter. My references to opening, radiating, expanding, and ascending movements are rather abstract and general, without much reference to the varying qualities of the movements. Among other things, I still need to ask: What does this particular flower’s opening express in the context of the plant’s entire gestural development, viewed morphologically, physiologically, and ecologically? How does the plant interact with the soil, air, and light, with insects and birds, and with the larger plant community? How does this flower’s character differ from that other species over there? I earn the right to generalize only to the degree I have penetrated the concrete, specific phenomena from which I am generalizing.

Of course, if I keep my comments as observationally faithful as possible, they are likely to contain at least *some* truth, just as a person uneducated in art can, if conscientious and careful in observation, say something more or less valid about a painting. But we need to keep in mind that the distance from *some* truth to *profound* truth is likely to be huge. To speak as I did about an “integral symphony of the morning” places a huge burden on me to understand in depth, not only this flower, but almost everything else in and under the sky. I have not even begun carrying out such a task here, having done no more than suggest a way to get started.

There is, however, one consolation in all this. While it’s true that talking about “the character of the morning” raises perhaps impossibly high expectations, the fact is that we are making the *same kind of judgment*

when we come to appreciate the expressive qualities of one particular flower—and even, in however minimal and unconscious a way, when we recognize from its expressive character that the flower is of this species rather than that one. Moreover, because we are always dealing with interpenetrating unities, we find our understanding of the flower leading us in ever-expanding contextual circles to the qualities of the largest whole we can encompass with our perception and thought. It is one of the features of integral wholes that every part is an expression and revelation of the whole. This helps us to understand how a person of profound artistic intuition might apprehend the world in a single grain of sand—or the song of the morning in a flower.

Light, Conversation, and Joy

I hope now that two brief, additional thoughts about the morning will not seem unduly strange. A sunrise is often felt, not only as a glorious, radiant event, but also as the occasion for an outburst of joy. If you consider the radiating and expansive gestures mentioned above, you will recognize that they are somehow resonant with human joy. All you need to do to verify this is to pronounce twice and in a heartfelt way, the sentence, “I am so happy!”—once while swelling your chest, letting your arms expand outward, and moving with your gaze into the surrounding environment, and once while contracting your limbs, body, and consciousness toward your center. In the latter case you will immediately recognize the grotesque inappropriateness of the movement, while in the former the movement seems perfectly natural, if not inevitable.

This is not to say that we should naïvely ascribe our human joys to nature. Nothing could be more foolish. But there *is* an objective, demonstrable connection between our joy and certain physical gestures, and this can only be the case because the gestures have an inner, speaking content.

My second observation has to do with that morning chorus of birds contributing so powerfully to our sense of joy. A friend of mine once remarked, “The sun rises, and the birds feel compelled to sing the light.” This puzzled me until I understood a certain gesture characteristic of all meaningful sound. Sound moves outward, like ripples from a stone thrown into a pond. But, again, I’m not referring primarily to the physical movement of air waves.

Often, if we’re wondering about the qualities of something, we can find initial guidance by turning our attention to the wisdom inherent in our everyday language. We are frequently *struck* by someone’s words;

even when spoken softly, words may *slap* us in the face or *hit* us in the gut. In other cases, the words may more subtly penetrate us, insinuating themselves into our subconscious. The cartoonist, with typical exaggeration, depicts someone being “blown over” by a shout, or he might indicate speech (or the song of a bird) by drawing lines radiating from the creature’s mouth just as a child draws lines radiating from the sun. If you try to imagine a movement in the opposite direction, you will immediately recognize that it does not fit.

Speech is undeniably an expansive and radiating, light-like phenomenon. Without light, the world is not there for us with any clarity. But without the conceptual illumination of the word, the world is also not there. We cannot see what we have not learned to discriminate through the conceptual power of the word. The word, perhaps we could say, is the inner being or essential meaning of the light—an idea, I imagine, that might prove fruitful for the physics of the future. Even now the physicist investigating light at the quantum level is inclined to say that the experimenter’s conversation with the light somehow shapes its manifestation.

Just as speech is light-like, so, too, the raying light has from ancient times been understood as speech-like. In the Upanishads it is recorded that “the Sun is sound; therefore they say of the Sun, ‘He proceeds resounding.’” Ananda Coomaraswamy, drawing on the ancient texts of the East, summarizes the matter this way: “The shining of the Supernal Sun is then as much an ‘utterance’ as a ‘raying’; he, indeed ‘speaks,’” and “The Sun himself ‘sings’ as much as he ‘shines.” Here, too, our routine language is suggestive, for we refer to “bright” ideas and “brilliant” sayings, and we respond “I see” when we have understood someone’s words. If we attend with any sensitivity to our actual meaning when we say these things—meaning that often arises from genuine perception at some level of our being—we can at least begin to appreciate the delicate interweaving of light and speech. Goethe seems to have been honoring this intimate connection when he wrote the following bit of dialogue in his fairy tale, “The Green Snake and the Beautiful Lily”:

“What is more glorious than gold?” asked the king.

“Light,” answered the snake.

“What is more refreshing than light?” asked the former.

“Conversation,” replied the latter.

I hope all this not only suggests a possible truth in my friend’s characterization of the birds as “singing the light,” but also may save us from the kind of arrogance at work when we hear the poet or prophet or

nature-lover say—“Heaviness may endure for a night, but joy cometh in the morning”—and dismiss these words as unscientific, merely subjective sentiment. Certainly our experience of joy may commonly be combined with purely personal elements, but this leaves open the question whether there is an objective character of joy not only at the root of our own experience but also displayed in nature herself.

A More Difficult Objectivity

There is a well-known school of acting, first articulated by the Russian actor and director Michael Chekhov in the first half of the twentieth century, based on the objective character of physical forms and movements. The actor, faced with the need to express, say, pride or mortification or joy, does not attempt to summon from memory a prideful or mortifying or joyful episode from his own past so as to reenter that earlier personal context and psychological condition. Rather, he finds gestures in the world from which he can draw directly the inner expressive character he is looking for. I have seen an actor, purely as an exercise, almost instantaneously transform his eyes into an expression of profoundest, tearful grief, while disavowing any sort of *merely personal* feeling. As Vladislav Rozentuller has written:

To move your hand toward an object in a certain hesitating and faltering way is (for the actor whose powers of perception and attention have been trained) to experience in the quality of the movement a feeling of distracted worry or anxiety. The feeling is objective in the sense that it belongs to the physical movement itself; the actor need not recall or imagine any purely personal anxiety. But, at the same time, the feeling does become *his* feeling. We could say that the experience has a subjective-objective character: the actor makes of his personal consciousness a stage onto which he invites this or that feeling from the objective world.

The actor onstage cannot help realizing that the world is word-like; every outer form corresponds to an inner content, and every inner imagination can be given its most natural outer form. A gesture can be grotesquely inapt or powerfully revealing—a simple fact that testifies to the significance, or speaking quality, of the world’s forms. The kind of training undergone by actors of the Chekhov school strikes me as very like one kind of training required by the practitioners of a new, qualitative science. The only way to recognize the wholeness of nature in all its expressive power is to perceive it with the full range of expressive powers of the

human being. The instrument of perception must be equal to its object. We will never develop a truly holistic science as long as the scientist continues to paralyze or imprison major human capacities—for example, the capacity to recognize the very real unity of a great work of art.

When we accept the human being as the primary instrument of scientific understanding—when we realize that we must discover within our own powers of speech what speaks in the world—then the need for uncommon inner discipline becomes apparent. This is what Owen Barfield had in mind when he wondered why there is any need “to make quite such a song and dance” about objectivity in the more usual sense. After all, it shouldn’t be so hard to get rid of personal bias if there is no genuine personal connection between ourselves and the things we’re investigating. “To put it rudely,” Barfield expostulated, “any reasonably honest fool can be objective about objects.” But it’s altogether different when we must attend

not alone to matter, but to spirit; when a man would have to practice distinguishing what *in* himself comes solely from his private personality—memories, for instance, and all the horseplay, of the Freudian subconscious—from what comes also from elsewhere. Then indeed objectivity is not something that was handed us on a plate once and for all by Descartes, but something that would really have to be *achieved*, and which must require for its achievement, not only exceptional mental concentration but other efforts and qualities, including moral ones, as well.

Indeed, the task may have been too great for humankind to attempt at the dawn of modern science. We can imagine there was a deep, unconscious wisdom in the resolve to shackle the greater part of the human instrument and subject ourselves to the discipline of mathematics, where rigor and objectivity *are* almost “handed us on a plate.” Without that preliminary training, it would have been nearly impossible to subdue the disorderly babel of voices still reigning in the human soul—voices of magic and superstition, of myth and legend, of religion and irreligion, of ethnic pride and prejudice—voices still capable of disrupting in childish ways the sober, geometric imaginations of Kepler, Galileo, and even Newton.

But we have completed this training—more than completed it, for we have carried our mathematization of reality to the unhappy point where the world begins to disappear behind a ghostly veil of abstraction. This veil conceals the perceptible, testable world from us as effectively as the old metaphysics ever did. Today, if we would test the phenomena around

us, we have the opportunity to bring to them not only our measuring rods and mechanical instruments, but our full-fleshed capacity to speak the living language of the phenomena, a capacity now chastened by our awareness that, in Goethe's words, "even where we do not venture to apply mathematics we must always work as though we had to satisfy the strictest of geometers."

We do not, after all, have to accept a science lacking in rigor. We only need to realize that there are two different, almost opposite ways to seek ideal clarity and precision. One is by following the path we traced earlier, admitting into our science only what we can grasp unambiguously, only what we can lay hold of, immobilize, and tie down, only what can be isolated as a separate thing and analyzed strictly in terms of its external or mechanical relations with other isolated things. In such a spirit (rudely disturbed by the discoveries of the past century), physicists have always sought for "fundamental particles"—particles lacking in qualities and accounting for the world's phenomena solely through their aggregate configurations, that is, solely through their clean, mathematically describable, external relations.

We gain a very different kind of clarity, not by minimizing the qualitative, phenomenal content of our scientific descriptions, but by maximizing it. We illuminate a phenomenon from every possible side, in every different light, exploring its contextual relations and potential for transformation as fully as we can. This clarity is not attained by stripping reality down to a formal grammar. It's the clarity produced by fullness of understanding rather than ease or simplicity of understanding. Instead of obscuring phenomena with the blinding white light of abstraction, and so reducing them to a kind of black-and-white skeletal syntax, we open ourselves to receive the phenomena in all their full-throated color.

Then, perhaps, it will not be too much to hope that we as scientists may learn to "sing the light" of creation—not as voyeurs staring at a cold and alien world disconnected from our own life, but as participants in a new morning of creation when, if we make ourselves worthy instruments, the Word will rise up in us as a song of understanding.