Transcending Biological and Social Reductionism

Frederick Turner

The poststructuralist dogmas of the social construction of reality, the human mind as a blank slate, and the work of art as sociological therapy, are coming under criticism by careful scholarship and science. It is becoming clear how much of our basic mental and experiential equipment is genetically given and neurologically based.

But the picture is not a simple one of biological enlightenment dawning after a dark night of social-constructionist obscurantism. We must not go back to the old doctrines of biological determinism and the human as genetic robot, or forget the reasons—good ones at the time—why social constructionism itself first arose as a corrective to Social "Darwinism." Religion is seen in biological-reductionist terms as a disease of subjectivity, sentience as impossible to understand, dreams as unimportant, freedom as a meaningless term, and art as snobbery combined with a kind of masturbation of pleasure centers that nature designed for more practical tasks. We must beware lest we replace social reductionism with biological reductionism.

Are evolution and art, evolution and literature, evolution and morality, evolution and spirituality incompatible?

There is a beautiful passage in Virginia Woolf's novel *To the Lighthouse* in which Mrs. Ramsay is faced with the challenge of pacifying two of her children who, like the seven blind men who set out to investigate the elephant in the old story, have different perceptions of the world. The skull of a ram has been nailed to the children's bedroom wall as a decoration (perhaps in the spirit of Woolf's contemporary Georgia O'Keeffe, who found those skulls beautiful). Cam, Mrs. Ramsay's fierce and imaginative little girl, finds the skull terrifying, won't sleep with it in the room, and wants it taken down. James, her little boy, resembles his father in his rigid, blue-eyed, philosopher's integrity, his ruthless determination to face up to the terrible truth of things. He insists that the skull remain where it is: he will not allow a mere girl to evade the harsh light of reality.

> Wherever they put the light (and James could not sleep without a light) there was always a shadow somewhere.
>
> "But think, Cam, it's only an old pig," said Mrs. Ramsay, "a nice black pig like the pigs at the farm." But Cam thought it was a horrid thing, branching at her from all over the room.
>
> "Well, then," said Mrs. Ramsay, "we will cover it up," and they all watched her go to the chest of drawers, and open all the drawers quickly one after another, and not seeing anything that would do, she quickly took her own shawl off and wound it round the skull, round and round and round, and then she came back to Cam and laid her head almost flat on the pillow beside Cam's and said how lovely it looked now; how the fairies would love it; it was like a bird's nest; it was like a beautiful mountain such as she had seen abroad, with valleys and flowers and bells ringing and birds singing and little goats and antelopes... She could see the words echoing as she spoke them rhythmically in Cam's mind, and Cam was repeating after her how it was like a mountain, a bird's nest, a garden, and there were little antelopes, and her eyes were opening and shutting, and Mrs. Ramsay went on saying still more monotonously, and more rhythmically and more nonsensically, how she must shut her eyes and go to sleep and dream of mountains and valleys and stars falling and parrots and antelopes and gardens, and everything lovely, she said, raising her head very slowly and speaking more and more mechanically, until she sat upright and saw that Cam was asleep.
>
> Now, she whispered, crossing over to his bed, James must go to sleep too, for see, she said, the boar's skull was still there; they had not touched it; they had done just what he wanted; it was there quite unhurt. He made sure the skull was still there under the shawl. (114-115)

In the rich metaphorical terms of the book, what James is insisting on is the then-new ideology of modernist Europe: we should not try to avoid the skull-like reality of the evolved physical universe, which is meaningless, stark, and made essentially of dead matter. James, like his father the philosopher, is a humanist atheist, believing only in the profound value of human life, and the noble calling of the human intellect to see the truth of things for what it is, that is, mere matter. Mrs. Ramsay does not dispute this view, but she feels it cruel to rub people's noses in it; and her role is to make that life we lead, between birth and death, as beautiful and meaningful as it can be, indeed as beautiful and as meaningful as the old religious universe was before science and philosophy unveiled it. So she winds the shawl about the skull, calming with poetry and art the fear of her daughter; but she reassures her son in his philosophical rectitude that the skull is still there.

Materialists remind us in a salutary way that we cannot simplify our ideals of meaning and our sense of ultimate concern by purging them of materiality. There is matter in the universe, and the finest things we know

are made of it. But materialism was simply the best estimate, at one stage of the development of science, of what the fundamental constituent and determining reality of the universe might be. As modern physics progressed, and the world was examined at finer and finer scales, matter itself dissolved into radiant energy, and then into wave-functions, which are a form of information. And self-determining emergent realities appeared, nurtured by complexity and irreducible to the characteristics of their material elements, yet unmistakably physical. A logical positivist today would be faced with a problem: his strict definitions of identity and two-valued logic would no longer apply either to the quantum world below the level of matter, or to the living world above it. Matter, whose characteristic of mass generates such standards of veridicality, was not there at the beginning of the universe, may not be there in its last phases, and may only be a peculiarly convenient algorithm of information; matter is not the only kind of physicality.

But Mrs. Ramsay has got hold of a part of the "elephant" that Zen Buddhists and Christian mystics are well aware of, which is essentially intangible to reductive and materialistic conceptions of fact. In this sense, God indeed does not exist. "Exist"—*ex-sistere*, to stand outside. He is not, in important senses, out there, but physically in here. The Tao that can be defined in "metaphysical" terms is not the Tao. Mrs. Ramsay's sense of the divine—for as far as I am concerned, she is a truly religious person—is of an emergent form, the attractor she generates in Cam's drowsing mind. (I use the term "attractor" here in the chaos-theory sense as the inner fractal preexistent form of a nonlinear dynamical system.) That attractor has as much reality as any other feature of the universe—and indeed more, since it is by such intangible arrangements as dynamic feedback systems, DNA sequences, mating rituals, ideas and aspirations that the universe is shaped and changed and transformed. Though Mrs. Ramsay does not believe in an afterlife, and will not try to deceive James that death is not a reality, she has found ways to survive in the hyperspaces of her children's dreams and her own interior dimensions of meaning.

Science will and should always prefer reductive, bottom-up explanations, since this is part of the method that distinguishes it as science. We cannot be sure something has a higher-level cause until we have eliminated lower-level ones, and it is easier and more reliable to establish or disprove lower-level ones than higher-level ones. But the method should not dictate the findings of the method. The very fact that science divides itself into disciplines such as physics, chemistry, and biology, whose focus is on different levels of complexity, is eloquent testimony that higher-level

systems cannot be adequately described in terms of lower-level ones, and thus that systems, as well as the components of systems, can be causes. If physics, which deals with more fundamental entities than chemistry or biology, could do the work of chemistry and biology, there would be no need for chemistry and biology. Science's glory is to establish top-down causality by assuming all causality is bottom-up and signaling honestly when the assumption turns out to be invalid.

Both reductionisms—social and biological—have focused on one aspect of evolution, the details of the ancestry of humankind, to the exclusion of perhaps more important and deeper ones (we could, perhaps, have evolved from elephants or dolphins or parrots, and many of the same issues might have arisen). Both sides, I argue, have hugely misunderstood the real, amazing point, which is that evolution, for the first time in history, has given an intelligible account of how novel realities could come into being. Creation now has a rational explanation, and a clear program of evidentiary proof for that explanation. In other words, we no longer have to abandon reason when we try to explain how the universe generates a new moment every moment, how the unbelievably beautiful richness of animal and plant species might have come about, how the forms of living things are so marvelously adapted to their function, and how the dust of the field, to which all animals demonstrably return when they die, can when rightly arranged, give them sentience and autonomous motion. And if we redefine freedom as creativity, that is, the capacity to generate novel realities, then it begins to look as if we have a rational explanation of freedom, too.

Indeed, the real point of evolution, as it emerges from the old ideological struggle, is that the universe itself is, to a large extent, free in this creative sense. Thus, far from being a triumph for meaningless determinism, the discovery of evolution may actually have been a victory for the realm assigned to religion—the territory of purpose, meaning, value, and freedom was now extended to include at least the living world, and perhaps, if evolution of a kind were taking place even before life emerged, the physical universe as a whole.

More recent developments in evolutionary theory have confirmed and deepened this conception of nature as inventive, active, unpredictable, and yet self-ordering and self-valuing. Chaos and complexity theory have shown us the biological universality of self-organizing nonlinear dynamic systems, where the complex interactions of many elements can constitute an emergent autonomous system. Fetal development, neural network function, ecological balance and genetic mixing within a species all share the common feature of

iteration with feedback as a novelty generator. The computer can model such processes, demonstrating the pure logic of their operation, while producing unexpected new forms that turn out to be uncannily similar to the designs of nature itself. Evolutionary theory is now recognizing the role of sexual reproduction in the generation of unique individuals, and the efficiency of individuality in speeding the process of evolutionary adaptation to the environment. If a species has a million distinct individuals, each with, say, its own style of foraging for seaweed, it has a million times better chance of finding the best seaweed foraging technique and perpetuating it through improved rates of reproduction than a species of identical clones. The individual is nature's experiment, nature's test-bed for the production of effective novelty. Thus evolution can no longer be seen as the enforcer of biological conformity and uniformity, but as the mother of individual uniqueness.

As evolutionary theory has developed, it has become apparent that evolution itself evolves. Time itself, in the theory of the physicist / philosopher J. T. Fraser, evolved from the atemporality of photons, through the prototemporality of quantum particles, the eotemporality of matter, the biotemporality of life, to the nootemporality of human beings. (See his *Time, Conflict, and Human Values*). One of Fraser's most profound insights is that we do not need to accept Plato's or Newton's conception of time as a sort of universal container for all that goes on. Furthermore, time need not necessarily come as a package, complete with temporal continuity, a direction, earlier and later, after and before, a past, present, and future, and the branchy timelines familiar to beings who must remember might-have-beens, use conditional and subjunctive moods, and decide on alternative courses of action. Why not posit of a given object, or state of the world, just the features of time necessary for its full description—whatever temporal elements implied by what it can experience and can do?

Fraser borrows von Üxkull's concept of the *umwelt* of an organism—that is, the specific world affected by its effectors and available to its receptors—and coins the term "temporal *umwelt*," which he then extends to all existent entities. A photon of light flying through a vacuum is, he says, essentially atemporal, since no feature of time is necessary to describe it in its own terms. A quantum particle occupies a single fragment of time, with no further features of time necessary for its description. A piece of coherent matter occupies a continuous timeline, but needs no after or before, or any other temporal baggage—one can reverse the orbits of bodies in a vacuum, or the tracks of individual atoms, without violating any natural laws. A living

organism, however, has a definite after and before, a distinct direction in life, and a human mind must grapple with the whole complex tense structure of its language, such as we find in novels, epics and plays.

Somewhat revising Fraser's categories in the light of other systems proposed by various cosmologists, I suggest the following "brief history of time" as a useful way of indicating the richness and variety of time, and casting doubt on the simple dimensional models of it that have dominated our thinking since Newton.

All that needs to be posited of the moment the universe began, according to contemporary mathematical physics, is pure mathematical logic. The most exciting mathematical ideas of the twentieth century, beginning with Gödel, deal with the incompleteness and open-endedness of any mathematical system, and its propensity to generate paradoxes that can only be resolved in terms of some richer and more reflexive system that includes it—a system that must in turn contain its own paradoxes, and so on. These relationships, of inclusion, containment, open-endedness, incompleteness, extension, "between-ness," and even, as in the case of the orientation of the imaginary number series with respect to real numbers, orthogonality and thus angles—immediately suggest spacelike dimensions. The discipline of topology may be defined as a demonstration that space, spatial dimensionality, is the only solution to certain problems in mathematical logic. Space is the way that true statements that would contradict each other if they were in the same place, space themselves out from each other. The Pauli exclusion principle, which states that two identical particles cannot occupy the same energy-state at the same place and time, is a physical example of this idea. If the two particles were in the same place, they would be both two and one, which violates the non-contradiction law of logic. In other words, a non-spatial world, if everything thinkable within it is to remain logically consistent, must necessarily generate a spatial world. Logic itself, as Gödel pointed out, logically requires a pre-logical truth "outside" it if it is to remain consistent—and that "outsideness" is already a proto-spatial relation. The spaceless universe thus must fall instantly into the condition of spatiality; up to ten dimensions of space have been proposed for its initial foray into this condition. It begins as an infinitely small, infinitely hot, infinitely dense, infinitely young speck of "thereness." Within this space-universe a unit of information occupies Fraser's condition of atemporality; were it to exist in time, it would be a photon.

Certain other problems in mathematics involve the relative easiness or difficulty of a calculation. Some calculations wind themselves up without

complication. Others involve more and more sub-calculations, and sub-sub calculations, before the calculator can produce an answer. In order to be able to contain such distinctions, and to measure their differences, another kind of dimensionality than space is needed: time. As the joke goes, time is nature's way of making sure everything doesn't happen at once. In its simplest form time is to the three spatial dimensions what the imaginary number series—the square roots of the negative numbers—is to the real number series. Time gives us a dimension within which we can describe the difficulty of a calculation, whether it is soluble in an amount of time that increases polynomially with the number of variables in it, or exponentially, or more swiftly still. The upshot is that the primal space-universe's own internal necessities, its scheduling problems, let us say, immediately cause it to inflate at a prodigious speed.

Thus spacetime emerges out of very logic; and given spacetime, quantum cosmology can show the necessity of the Big Bang. The quantum vacuum, say the cosmologists, is not an inert nothingness but at some scale a foam of particles and antiparticles, with a net value of nothing but the potential for one of these particles to escape annihilation by its opposite number and swiftly balloon up into a new universe. Energy emerges out of a spacetime field as the coherent solution of certain possible and necessary geometrical paradoxes, and sometimes binds itself to a local place and continuous existence, collapsing into matter as the universe cools with its expansion. The quantum world, still too hot, young, small, and simple to contain anything other than quantum particles, is in the condition Fraser calls eotemporality; a quantum particle, that is, possesses an eotemporal *umwelt*.

Matter is the solution to paradoxes that arose in the energy universe as the primal superforce separated itself out into gravitation, electromagnetism, the weak and the strong nuclear forces. Not every possible kind of energy and matter does emerge, and once having emerged, survive; there are apparently no magnetic monopoles, though there could have been; and there is very little antimatter, since at the point of the collapse into matter, physical laws demanded that the energy universe choose one or the other but not both for its debut into materiality. Many possible isotopes do not exist because the conditions of their survival are not present. Thus a peculiar primitive kind of "choice" already existed at the very beginning of things. Various exotic kinds of matter emerged—we can reproduce their emergence sometimes in an accelerator—but were selected against by the existing ecology of the physical world, and did not survive for long. Tough objects like protons and neutrons, or intangible ones like neutrinos, can survive a

great deal of wear and tear, and so they are long-lived and plentiful, as are certain elements, like hydrogen and iron, and certain molecules and crystalline structures in cooler and quieter environments. Fraser calls this the prototemporal stage of the universe.

Given matter, another open-ended process begins, of thermodynamic interaction and chemical recombination. Once there exist large enough ensembles of matter, each element of which is free to interact with every other, new statistical and collective effects emerge, including what is to become one of the master-principles of the material universe: thermodynamic decay, or the increase of entropy with time. Time now takes on a distinct direction. One can burn a log, but not easily unburn it; one can allow a bottle of perfume to diffuse into the air of a room, but not easily collect it back into the bottle; one can let hot gas and cold gas mingle themselves in a container, but not easily separate them again. Work energy gets used up and broken down into waste heat. Fraser does not give this stage a name of its own, and I have suggested that it be called the thermotemporal, or chemotemporal.

Here again we find a process of variation, in which the vicissitudes of a rather violent universe thrust together arbitrary combinations of chemical elements, and in turn test them to destruction, leaving the survivors to survive. But in chemistry those survivors can only endure, or at best grow by accumulation, as crystals do. They cannot avoid, adapt to or anticipate the threats of a dangerous universe. Nor, if they are especially successful at weathering or dodging the dangers, can they copy themselves so as to improve their statistical chances; yet the logic of survival in time would demand that they should. Their potentially successful form is held hostage to a particular local piece of matter; if the form could be copied to other matter, then the form might survive the enemies of matter—heat, mechanical destruction, chemical corrosion. And so yet another solution to an existential paradox emerges—life. Here we enter the realm of what Fraser calls the biotemporal.

With life a new element joins the iterative variation / selection algorithm by which evolution had proceeded: heredity. Life has, as it were, a double life; as matter, and as a recorded copy of the form of that matter. It is more reflexive, more conscious, so to speak, than matter by itself. (Of course, as we have seen, matter is itself "double" with respect to its substance, energy: it is energy, but also a self-maintaining field structure containing the energy. And energy is "double" with respect to the spacetime field, and the spacetime field "double" with respect to mathematical logic.) Life not only evolved in

a new way, by self-copying; it also developed in turn new forms of evolution. One of the most remarkable of these is sexual reproduction, which, instead of merely accepting mutation as part of the damage of existence, actively anticipated and promoted it by sexual recombination.

Now the biosphere took increasing control over the nonliving substrate of the planet Earth, radically altering the composition of its air, regulating its climate, setting up complex chemical cycles throughout its atmosphere, hydrosphere, crust and perhaps even its mantle. It is thus entirely natural for an emergent and more reflexive kind of order to control and subordinate the earlier and more primitive forms out of which it evolved. Complex social species, their individuals coordinated with each other in swarms, schools, groups, packs, and bands, their own evolution partly controlled by mating rituals and social ranking systems, established new features of time: a distinct present, to synchronize their actions, together with rudimentary systems of memory (and thus a past as such), and even the dim anticipations, expectations and drives that constitute a future. Fraser dates the emergence of the sociotemporal *umwelt* to a later phase in the world's history, but I would place it here.

As the competitive-cooperative ecology of the living world became more and more complex, and improved forms of biological evolution accelerated the rate of speciation and ecological change, the Darwinian mechanism of biological evolution began to reach its speed limit. It takes perhaps a hundred thousand years for a higher species to develop a new capacity in response to its experience in the environment; and the whole species, or most of it, must go through that experience in order for the selective process to work. Would it not be better if something like Lamarckian evolution were to supplement Darwinian evolution?—an adaptive process that could make appreciable changes in one generation, which could use the experience of individuals rather than that of the gene-pool as a whole? Would not evolution be still more efficient if alternative scenarios for the future could be tried out in a virtual world where they could do no damage, before they were actually embarked on? Would it not be better to supplement the very slow genetic diffusion of information through the species, with much faster forms of communication independent of the reproductive process? Might not new forms of information storage be developed, above and beyond the genes, which would be to the genes what the genes were to the matter of which their bodies were made, or as the structure of matter is to the energy it binds?

The answer to these questions was, of course, the human species: its traditional rather than genetic way of mutating the racial store of information, its brain, its memory, its language, its cultural institutions, its imagination.

Again, this new emergence was the solution to paradoxes implicit in the nature of the universe that preceded it. Survival, now revised and enlarged in definition beyond reproductive success to control and prediction of the biosphere itself, and to a richer existence within many possible time-lines, required a faster acceleration of the adaptive process than biogenetic evolution could provide. Humanity is the solution to the paradoxes of life, as life was for matter, as spacetime was for mathematical logic. Thus the dawn of the nootemporal *umwelt*.

In this denser and more complex kind of time in which we live, we did not leave behind those simpler levels from which we emerged. The components of our bodies contain and experience the lower *umwelts*. When we get caught up in a ritual celebration or political rally, we are in the sociotemporal *umwelt*; when we dream, so some brain scientists tell us, we are undergoing some aspects of the time-experience of animals; when we age, we feel the one-way current of thermodynamic decay. When we slip and fall, we are as physical bodies subject to the same classical mechanics as circling moons and hurtling atoms; and as clusters of frozen light, we are fossils of the timeless moment of the Big Bang. These levels of temporality in us are often at war—the nootemporal dieter against the biotemporal gourmand, the sociotemporal conformist against the nootemporal person of conscience, the biotemporal animal survivor against its own slow thermotemporal furnace of burning chemicals, the nootemporal dancer against the prototemporal point-mass in free fall.

Of course, the irony of our evolutionary progress is that the paradoxes get more complex with each new solution of them; and the human paradoxes are the most pressing and difficult of all, especially as, unlike their predecessors, they have not yet been solved. Those thinkers who have in despair, or in denial of their shame, or in fashionable cynicism, condemned the human species and its progress, have not reflected that in a sense the imperfection of things goes all the way back: existential tension is most primitively the paradox of self-inclusion. If they would turn back the clock to some imagined innocence, they would be cutting off the very process of existential tension by which the universe came to be. But cannot we think differently of the unsolved human paradox?—as the open-endedness of the universe, as its evolutionary potential, as its great hope, as our chance to prove our creativity, as our solidarity with the whole cosmos in its great questioning expansion and fall, outwards into richer, more anxious, more complex, and more beautiful forms of being?

Thus even the way evolution takes place becomes more and more refined, more and more a function of the choices of individuals, more and

more—dare I say it?—spiritual. Evolution properly understood is a resounding validation of the human values that the Victorian anti-evolutionists were defending. Ancient theology postulated that spirit emerged from matter by a process of refinement, an idea rejected by Enlightenment rationalism: current evolutionary theory has in a strange way revived that notion, giving spirit a decisive place in the physical universe. In the light of contemporary computational theories of the physical universe, we might redefine "spirit" as physicality's constitutive richness, recursiveness, concreteness and density of information, rising to its deepest complexity in higher social animals and human beings.

Where do we stand now? On one side are supporters of evolution who want the world to be meaningless, purposeless and directionless. If there is no such thing as a human moral nature, no such thing as a natural soul—and if as a secular nation we must discount any supernatural soul—then existentialist lifestyles, state nannyhood, and the university's role as a new priesthood of the national conscience become mandatory. If there is no destiny for the universe and humankind, secular artists and philosophers are free to make one up. On the other side are the religious opponents of evolution, who are willing, with pathetic heroism, to entertain the grotesque pseudoscience of Creationism as a sort of spiritual/intellectual sacrifice to their faith.

Both sides stand on shaky ground in their own terms. The view of nature as unteleological and devoid of purpose can be refuted by a simple thought experiment. Suppose, in an unteleological universe devoid of purpose and meaning, a random set of genetic mutations created one species of beings that acted as if it had purposes and goals—say, the future survival and perfection of the species itself, even at the cost of self-sacrifice—and as if the universe as a whole were hospitable to such purposes. And suppose that such behavior, together with the perceptual and cognitive structures of prediction and the neurochemistry of emotional motivation that would support it, turned out to be strongly adaptive—that is, they promoted superior cooperative behavior, anticipation and preparation for threats and opportunities, care and nurture of the young, and an enhanced representation of that species' genes in the next generation. This species, with its Quixotic and entirely false assumption of meaning and value in the universe, would out-survive the more realistic species whose assumptions were that there was no future worth striving for and that one should live for the moment. Over evolutionary time the world would become filled with species that were either descended from the teleological species, or had competitively

adopted teleological behavior in self-defense. We would end up over time in a universe crammed with value, meaning, purpose and destiny.

It might be objected at this point that I am collapsing the fact-value distinction. But it could well be argued that such a collapse is precisely the goal of all serious philosophy, and that it is only the strategic severity of our definitions of fact (as explicitly excluding value) and value (as explicitly excluding fact) that is getting in the way. Concede even that beauty, value, meaning, freedom, planning for the future, teleology, soul, etc, were indeed complete nonsense; nevertheless for a species to operate as if they were real—by nurturing its young, self-sacrifice, ritual celebration and the like—such a species would be at a competitive advantage with others. But that concession is now a purely metaphysical one, with no practical or scientific relevance. Those "abstractions" will have become laws of nature. Good hard empirical science would tell us that of course the universe is full of value and purpose. If values are for animals as functional as teeth, that does not make the values any the less values than it makes teeth any the less teeth. Only if we let the likes of Kant dictate our definition of value—as essentially unlike teeth—is there a problem: but it may be that Kant's values never existed anyway, and the word value would be more useful applied to something that does exist. If values necessarily evolve in the struggle for survival, belief in the meaninglessness and valuelessness and directionlessless of the universe is an act of purely religious faith, maintained in the face of the cold hard facts of meaning, design, love, progress and beauty. The austere and faithful dialectical materialist, in his sackcloth and ashes, could then say with the mystic "Credo quia absurdus est"—I believe because it is absurd.

The religious anti-evolutionists, however, are vulnerable from an entirely different direction. Oddly enough, they are just as much children of the Enlightenment as their secular atheist enemies. The Bible is actually a deeply evolutionary work. It tells of a God who is emphatically not outside of time and the universe but inside them, who is in a continuing and developing relationship with human beings and the world, a world that emerges in a temporal sequence, starting with the simplest forms of being and culminating with the most complex and conscious ones. Jesus tells parables like those of the sower and the mustardseed, which, given the terms that first-century Jews might understand, could scarcely be a clearer explanation of the principles of selection and adaptation. If Darwin were to go back to ancient Palestine, he would probably start talking with these experienced plant and animal breeders in precisely such terms—the seed falling on barren or fertile ground, being eaten by predators, and so on. The Bible is a book whose God

is deeply involved with nature, with Job's whirlwind and the leviathan, and for whom the style of creation by evolution would be entirely in character. The Theist Enlightenment God who would create the world complete, in a sudden, eternal and arbitrary moment, might be an awesome being to imagine: but he is not the God of the Bible, and religious anti-evolutionists need to be deeply concerned about the possibility that, with the best of motives, they may be nursing an eighteenth-century rationalist heresy.

Today the God of nature looks very much more like the God of the Old and New Testaments, and the God of other great world religions, than like the abstract God of the Enlightenment. Evolution is God's own vital signs. And this means that in the old language of communion, we are literally gathered in to the body of God, if God is evolution itself; numbered, perhaps, among the humble and ignorant neurons of Her mind.

It is the interaction of nature and nurture itself that is the real object we need to study. The trouble is that social constructionists and biological reductionists both see the initiating conditions of human behavior as fully explaining it. But what is really interesting is how richer and more complex and more value-laden structures and functions can emerge out of cruder raw materials, to transcend and govern those materials. Thus the "tail" of art, religion, and so on can come to wag the dog of biological inheritance—the genes can be systematically seduced and domesticated to the service of higher values.

Interaction—this is the key. Once the individual or an ecosystem has emerged, its structure is so complex and the way it got there so iterative and tangled that the initiating conditions are largely lost in the integrity of the whole, as the brushstrokes of a Rembrandt or a Michelangelo are lost in the commanding image that organizes them. In an almost Aristotelian way, the Final Cause of the adult individual seems to pull the fetal developmental process toward its goal; and in an almost Platonic way, the strange attractor of the process itself, fractally deep and inexhaustible in its elegant articulations, seems to hang above or reside within the mere matter of the organism. Evolution itself is the archetypal iterative nonlinear dynamical feedback system. One could interpret the same facts that the neoDarwinists describe in terms of genes "trying" to survive through their expression in individual organisms, as archetypal species-forms "sorting" through the huge random catalog of genetic recombination for a "good enough" mess of protein-makers to embody their development.

Biological "survival" is a grand, breathtaking, and accurate metaphor, but a metaphor. (See Table 1.) Nothing of a gene is surviving in material reality when it reproduces; what "survives" is a piece of abstract information,

the sequence of nucleotides on the DNA chain. My liver dies and resurrects itself every forty-eight hours or so. It is no more "surviving" than a flame. A chunk of granite that has survived in good hard fact for a billion years would, if it could, both laugh and shudder at the lunatic claims of a living organism to be surviving by hatching its eggs and then dying, or even by eating and excreting. Yet life is very effective—there is as much limestone around as granite, and limestone is the corpses of living organisms. A mere phantom—a pattern of information—can move mountains; for the crustal plates of the Earth and the eruptions of volcanoes are now driven by the boiling and fizzing of life-created rocks as they are subducted into the mantle. And if so abstract, so spiritual a thing as that pattern can masterfully determine the structure of large chunks of matter and the whole surface of our planet, why should not the even more abstract and metaphysical entities of goodness, freedom, God, soul, and beauty?

I have argued that the missing category in both the social and the biological reductionisms is beauty. Only with an aesthetic eye can we come to really understand what is going on in nature, because the aesthetic eye is the organ nature has evolved in us for seeing the inner form of complex interactions. Our genes determine our bodies and brains, and they determine how we think and feel and behave. True. But our feelings and thoughts determine our behavior, which determines how our brains and bodies grow, and whom we choose as a mate, which determines how future genes will be distributed in the species. Only the aesthetic vision can turn the dizzying circularity of these propositions into the loveliness and intellectual clarity of a great Madonna and Child—*figlia del tuo figlio*, daughter of thy son—or the striking cognitive beauty of a theory of evolution through sexual selection and reproduction.

University of Texas at Dallas

Table 1

The core concept in the evolutionary paradigm that lies at the heart of the sciences is SURVIVAL. The concept of survival implies two questions:

The survival of what?

Into what?

To answer these questions we require a new concept:

SURVIVAL PHASE SPACE.

(continued next page)

Table 1, Continued.

A phase space is the number of dimensions required to map the various characteristics of a given system; e.g. a moving cloud of cooling gas might require, as well as the three dimensions of space in which it moves and a time-dimension to map the movement, additional dimensions, such as temperature, chemical composition, dilution, and pressure to fully map all of its states and behaviors.

A *survival phase space* is the phase space that describes the possible dimensions into which a survivor can be said to survive. A rock, for instance, survives trivially in all three dimensions of its physical presence, and in a single linear time dimension, bounded at one end by its cooling from lava, and at the other by its mechanical shattering, erosion, melting or vaporization. Different kinds of survivors survive into different sets of survival phase spaces, as shown in the following table. If we ignore the three spatial dimensions, which any physical entity requires for its description, we are left with the various temporal dimensions into which it endures. Note that later phase spaces appear to earlier ones like counterfactuals, though they are just as much "real" parts of the universe once they have emerged. But note also that later modes of survival include and do not escape earlier ones.

SURVIVOR	SURVIVAL PHASE SPACE	PHASE SPACE SYMBOL
1. QUANTUM EVENT	Point-space: event exists (survives) in Planck time only	S0
2. MATTER	Linear space: object exists (survives) along an Einstein / Minkowski geodesic	S1 (i.e. geodesic x S0)
3. ASEXUAL LIVING REPLICATOR	Plane space: DNA sequence survives in space of all clones in the same lineage	S2 (i.e. clone set x S1)
3. SEXUAL REPLICATOR	Volume space: genes survive in space of all interbreeding conspecifics	S3 (i.e. gene pool x S2)
4. SOCIAL REPLICATOR	Hyperspace 1: "memes" survive in space of all possible gene / culture coevolutionary variants:MORAL SPACE	S4 (i.e. social world x S3)
5. MENTAL REPLICATOR	Hyperspace 2: "soul" survives in space of all imagined and volitional alternatives: conditionals,subjunctives, fictions, the kingdom of heaven, etc. SPIRITUAL SPACE	S5 (i.e. mental world x S4)

Works Cited

Fraser, J.T. *Time, Conflict, and Human Values*. Chicago: University of Illinois Press, 1999.
Woolf, Virginia. *To the Lighthouse*. New York: Harvest Books, Harcourt Brace, 1927, 1955, 1981.