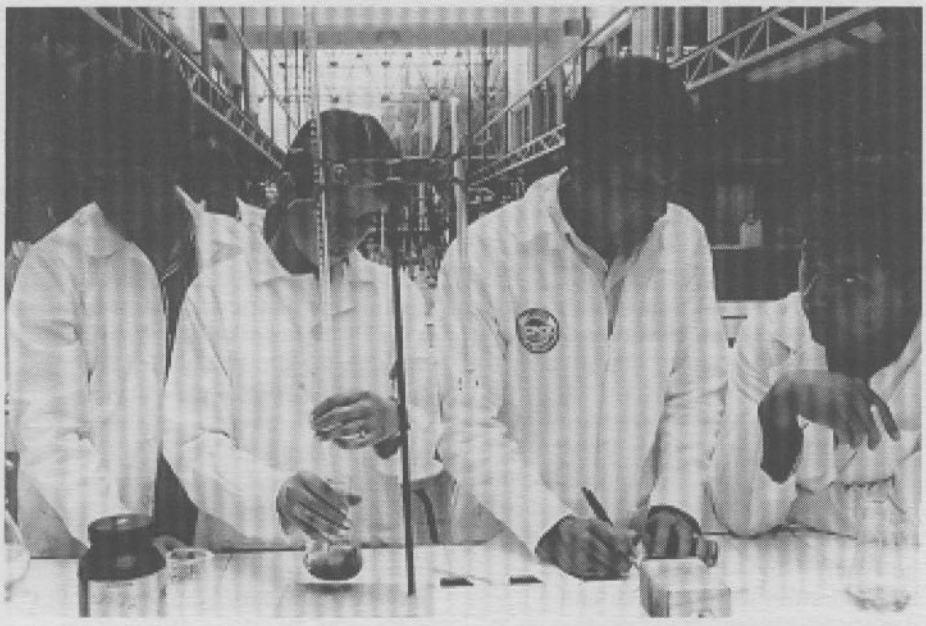

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useful midrange goals but subject to redefinition according to developments. For instance, peace among nations may he an irrelevant goal if we no longer have nations in the post-renaissance sense (and if we do have nations in that sense, peace may be impossible). Harmony among smaller communities may not even be a good idea, if we recognize aggression to be a natural human drive; at the local level it may make more sense to seek channelled forms of war than to seek peace. Some formations of the word *justice* —economic justice, social justice— may be illusions based on category mistakes. If the modifiers *economic* and *social* refer to fields of study demarcated arbitrarily by academic specialization, but not to entities with real independent causal force, and if *justice* refers to a course of rule-governed ethical activity, then the connection between the words may be both specious and tenuous. If economic and social phenomena are, as the collapse of socialism suggests, the symptoms and appearances of deeper cultural and biological causes, as redness is of rust or silence is of thought, then to try to change them without changing the underlying causes would be like trying to make zinc rusty by painting it red, or to make a squeaky door think by oiling it.

Likewise, *equality*, especially if deprived of the transcendental justifications implied in Jefferson's phrase *created equal*, becomes problematic. One law for the ox and the lion, said Blake, is oppression. Where is the line drawn in the assignation of equality? Are the criminal and the victim equal in every way, or only in certain strict legal ways? What if the crime is rape? How do we draw the line? Who draws it? We are in the process now of assigning equal status not only to all human beings (except, surprisingly, children, infants, and fetuses), but also to animals, and even to plants. 1 have heard it argued that inanimate chunks of rock have as much right to exist as human beings. More problematic still, why should the diseased kidney be denied equality with the person who carries it? Why should the AIDS virus die and the patient survive?

Nor can *freedom*, that glorious inspiration for so many works of art and public acts of violence, escape a soberer analysis. Freedom, we now see, is not absence of restraint, nor can it be mere power. It requires personal weight, being, dignity, self-discipline, the exchange of gifts, the location of the free subject within a web of obligations, commitments, responsibilities, promises, and long-term goals. We used to think of freedom as being able to *turn on a dime*, to change direction on a whim as rapidly as we wish —just another word for nothing left to lose. Freedom now seems much more like being able to change *momentum*— that is, to keep one's weight and reality and one's prehensile relations with ones environment as one changes. Only a lightweight can turn on a dime. True freedom is slow, massive, unwieldy, real, and changes the cosmos about it not by a one-way imposition of power but by a subtle feedback of obligation, example, debt, and taking-into-account. But these qualities are too dull for social idealism.

The present endpoint of the drive for freedom in the modernist sense is the condition of an inner-city delinquent, free of any cultural restraints on his behavior (restraints that the human body and nervous system are designed to incorporate, as we are designed to breathe air and resist gravitation), free from family pressures, job stress, political oppression (nobody cares enough about what he does or does not do or say to try to change his behavior, as long as he does not kill or rob them): free from history, from rationality, from rules, from obligations, from routine. The perfect existentialist.

But of course such a person is also the perfect victim, oppressed chiefly by his own addictions and disordered biological desires, and

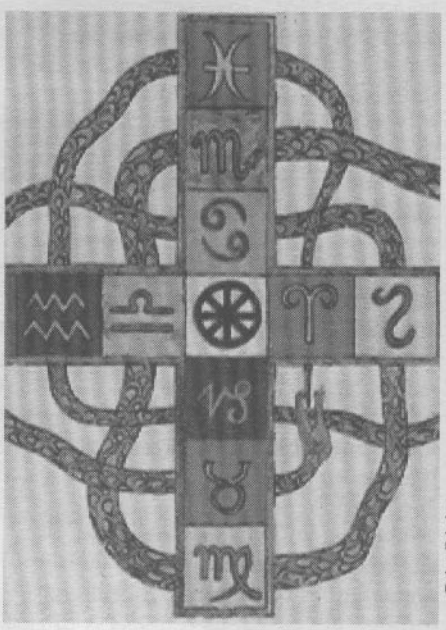
secondarily by those people in his immediate neighborhood who, because of their greater self-control, are able to use him to the extent that he is useful. Such a person is not oppressed by *society*; he does not possess anything worth going to the trouble of oppressing him *for*.
The claim of social oppression is sometimes a kind of pathetic bravado, an anachronistic reminiscence of times when a proletariat with its own deep traditional culture and values, and its own sources of creative energy, could be profitably exploited by an owning class. Today a capitalist entrepreneur would be doing the underclass delinquent *a favor* by trying to exploit and oppress him; would be overestimating his economic value, would likely lose his shirt. These are horrible truths; but the rhetoric of freedom —or equality, or even justice— is no help at all. Our delinquent quite possibly *deserves* his present misfortune, if we were to balance out his good deeds against those which have injured others. And the greatest source of injury to him are his poor wretched teenage mother and his absentee father, who brought him into the world. It would be monstrous and meaningless to exact a just punishment from them.

The only values which even begin to meet this case, the only hopes that can coherently apply, are the ones which go altogether beyond social expectations, ameliorations, and hopes. The ghetto delinquent is a human being, worth Mozart's Requiem; his brain and body are the holy flower of four billion years of evolution; he is in potential the beauty of the world, the paragon of animals; in action how like an angel, in apprehension how like a god. And to make these kinds of assertions, and to take the kind of action that will really help the delinquent and all our other brothers and sisters, we need the full equivalent of the great religious hopes that built the cathedrals and the temples, that filled with fantastic light the meadows of Van Eyck's Ghent altarpiece. This is no fantasy, but hard commonsense: the only schools that have shown consistent success in educating discarded inner-city youth are the Catholic parochial schools, which operate according to religious ideals of human value not much different from those I have so embarrassingly listed. The burden of proof rests upon any other theory.

Thus in the new constellation religious hope would once more have a central place. But it would have radically changed. Its prime intellectual directive would he syncretism —that is, the incorporation within higher and deeper religious ideas of the tenets, theologies, and observances of all the religious traditions, together with the new revelations that continuously pour forth from the sciences. Religion would be at the leading edge of science. Traditional religious concepts and metaphors would be recognized as culture-bound, partial, but valid formulations of the evolutionary direction we should take and have in general been taking, and as the missing component of social hope. The conflicts among religions and theologies would be mitigated and transformed by a dramatistic ethic, in which differences of ideas would be taken as the very stuff of the divine drama, and would be cherished as the life and breath of the spirit; their dialectic would be part of the very evolution of the divine fetus towards its maturity. The contradictions within the religious drama, and between it and the other institutions of society, would be accepted as part of the mortal shame of our condition, a shame whose sacrificial recognition and celebration would become the portal to an epiphanic beauty and prophetic revelation, the fuel of evolutionary hope.

Thus the state would not need to preserve religious freedom by paralysing religion: religious freedom would be the central value of religion itself. As religious hopes evolved, they would draw into themselves more and more of the richness of ancient human traditions.
For genuine progress, as I will argue, is not the rebellion of the present against the restrictions of the past so much as the breakout of the vital past, through the dead habits, expectations, and routines of the present, into a future that is a rebirth of the past in a new and unpredictable form.

As may already be clear, this project involves a radical transformation of our accepted rules about disciplinary boundaries and regions of discourse. When Kant proposed *culture* as a mediating term between nature and civilization, he could not have known that it would in turn become the opposite, antithesis, and antonym of nature,
and that the dichotomy in turn would spawn that whole brood of academic disciplines and subdisciplines in whose toils any larger discourse is



necessarily lost. We must, if evolutionary hope is to be possible, be prepared to abandon the clear borders between nature and culture, science and the humanities, technology and art, and thus to relinquish our hostility toward whichever of these we perceive as being the other to our own position. We must accept a ground-changing, open-ended, though traditionally-based, view of what is hoped for. Value inheres neither in parts nor wholes, but in the relationships between them; and value is the only fuel of hope.

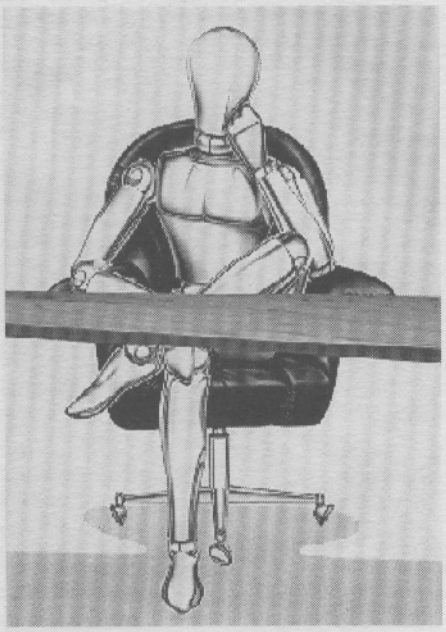
II. Beyond the Disciplines: The Local and the Global

Last year, when we were beginning to organize this seminar, we visited the pyramids of Teotihuacan. This year, in my reading on the ancient civilization of the Yucatan, I have found myself fascinated by the Mayan calendar. These constructions were intricate mental machines for the integration of knowledge.
The conquistadors brought with them another such machine when they came to the Americas —the Great Chain of Being, devised by Aristotle and Thomas Aquinas, the divinely-appointed hierarchy that contained all beings from angels down to clods of earth.
Let us construct for ourselves such a machine for the integration of knowledge— for it is clear that we need to do so.

Clearly something is missing in the way we are educating the next generation. I believe we must look to the content of education —its conception of the shape of the world, and therefore its manner of introducing students to it— for both a diagnosis and a cure. What is that missing something? Most fundamentally it is a sense of cognitive unity, a unity which imparts meaning to the world and from which our values unfold.
The great obstacle to our perception is the academic curriculum in its current shape. The last four hundred years of scientific and intellectual progress contain a gigantic paradox. Every great advance, every profound insight in the sciences and other intellectual disciplines, has torn down the barriers and distinctions between those disciplines; and yet the institutional result of each of these achievements has been the further fragmentation and specialization of the academy.

Let us consider the following list of disciplines: mathematics, physics, chemistry, biology, anthropology, the arts and humanities, theology. This list is not in random order; it represents roughly the sequence of prerequisites that one will usually find in a college catalog. That is, a theology major will usually be expected to take arts and humanities courses; an arts and humanities major will be encouraged to take something in anthropology; an anthropologist will surely be expected to take physical anthropology, which requires some knowledge of biology; a biologist must know some chemistry; a chemist must have a working understanding of physics; and a physicist is lost without mathematics.
I believe that this sequence reveals a certain instinctive wisdom in the academy, though its larger implications would be denied by many academics. This wisdom points toward a vertical, as opposed to horizontal, unity in the world, a unity which is implicitly denied by many of our fundamental academic metaphors —*field of study*, *department*, *the language of a specialty*, even *discipline* itself. We need a new metaphor; what follows is a search for it.

Issac Newton, the founder of modern physics, is often credited with the invention of the first specialized academic discipline. But Newton's greatest achievement was to unify mechanics, astronomy, algebra, geometry, and optics in such a way as to bridge the border between mathematics and physics, so that from his time forth there could be no physics that was not based on mathematics. Interestingly enough, this connection only goes one way; that is, it would not be accurate to say that there can be no mathematics



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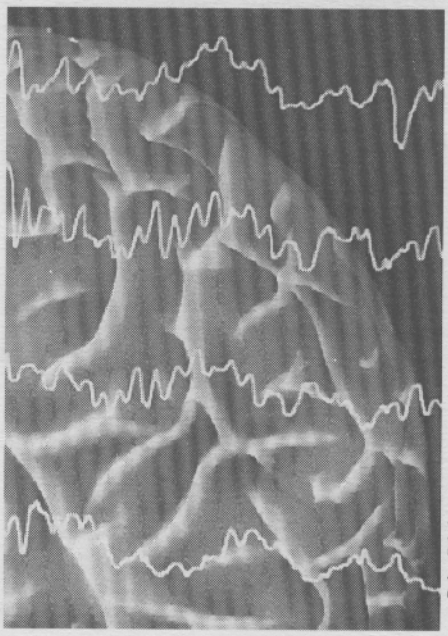
which is not based on physics. The mathematics of physics, though the only mathematics which is actualized in space and time, is only a subset of the total set of possible mathematical concepts and operations.

Let us consider another great scientific achievement: the reduction of chemistry to physical principles by such nineteenth-century scientists as John Dalton, whose New System of Chemical Philosophy may be as important as Newton's Principia. Chemistry could be no more than

a series of isolated observations until the principles of atomic weight, specific heat, and chemical combination and valence had been established and, above all, until the periodic table of the elements had been drawn. But all these discoveries were in essence a demonstration that chemistry is really a subset, or branch, of physics —that a chemist clinches any argument about his or her conclusions by demonstrating its derivation from known physical principles. Now, much of physics deals with a world in which chemistry need



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never have come into being, except insofar as chemistry is required to bring about physicists. Indeed, there is no chemistry over three thousand degrees centigrade, and because the universe is believed to have begun at a very much higher temperature than that, the laws of physics were sufficient to describe its operations until it cooled sufficiently to permit stable molecules to form. So both the logic and the history of chemistry describe it as a special case of physics, whereas there is no sense in which physics is a special case of chemistry.

But we need not stop here. One of the most decisive discoveries in biology was that of the double helix structure of the DNA molecule. From this point on, no biologist could be considered to have consolidated a conclusion until it could be demonstrated to be plausibly consistent with the biochemistry of life. In other words, biology is a huge branch of chemistry— biology is what chemistry does when given a volatile cesspool like the planet Earth and some billions of years to play around with. Again the relationship between the disciplines is asymmetrical: chemistry is not a branch of biology, and one could fairly say that the microstructure of biology is chemistry.

Consider now, anthropology —in its broadest sense, as including sociology, psychology, political science, economics, all the other human sciences. Just as the liveliest controvers —vitalism versus mechanism—once surrounded the reduction of biology to the interaction of dead matter (that is to say, chemistry), so now the most vigorous argument involves the extent to which the study of human beings is fundamentally the study of an animal species. A remarkable species we are, truly, say the pioneers of this view —as chemistry is a remarkable kind of physics and biology a remarkable kind of chemistry— but an animal species nevertheless. There is a massive convergence in process among the fields of paleoanthropology, sociobiology, human ethology (the study of human behavior as one kind of animal behavior), neurology, psychophysics, linguistics, genetic archaeology, and archeology, and this convergence points to the imminent collapse of the old boundary that separated the study of humankind from the study of the rest of nature. But again, the relationship —between biology and anthropology— will be one-sided. Biology is not a branch of anthropology, but it may well be that anthropology is a branch of biology, and that the microstructure of anthropology is biology.

But we do not like being compared with animals; we believe that we are free and animals are not. But there is no reason to believe that our biological descent makes us automatons, any more than the other higher animals are. On the contrary; what other rational account of the appearance of novel entities in the world is there than evolution? And what is freedom but the ability to generate novel entities? As biological evolution produced that radical novelty known as humankind —as it had earlier produced the radical novelties of eukaryotes, vertebrates, and primates— so that enormously accelerated version of evolution which we call the human imagination is capable of the leap into a new world, the leap called freedom.

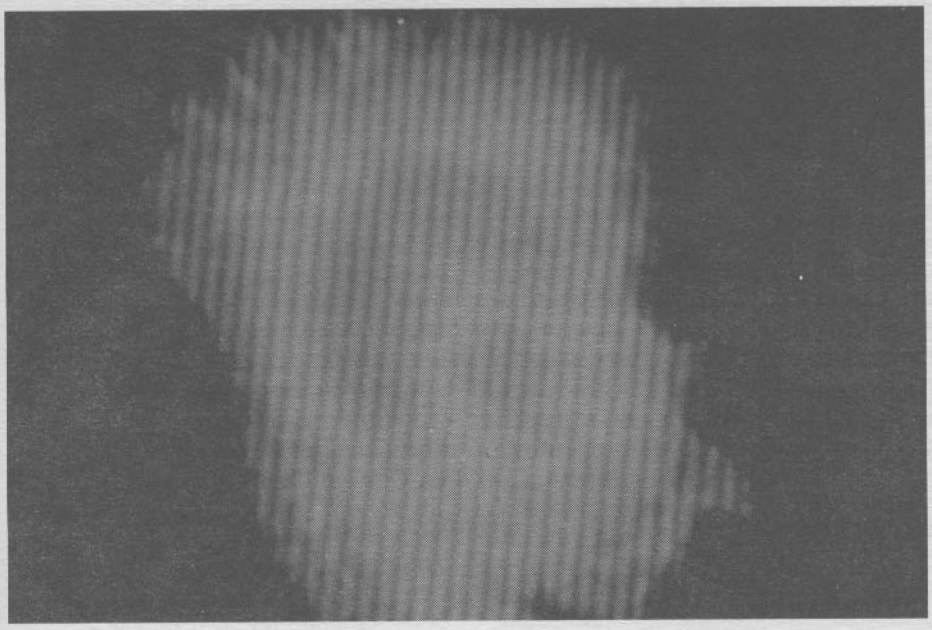
But we cannot stop even here. The same ferment that is seething at the border of biology and anthropology is going on at the border of anthropology and the arts, in such fields as cultural anthropology and folklore. And the result of this ferment will be the final recognition of the arts and humanities as a branch, or subset, of anthropology. So art history, literary criticism, and the rest will have to validate themselves —as chemistry validates itself physically, and as physics validates itself mathematically— by reference to sound anthropological knowledge.

Finally the time will come when the boundary between theology —the study of the divine— and the arts and humanities will be breached in the same way, and we shall evaluate and temper our religion on the basis of

what our arts and humanities tell us about ourselves. When this time comes, Francis Bacon's and Rene Descartes' great split between the divine and the natural will have been healed, and we will be back on the main road of human cultural evolution.

In a certain limited sense, then, all academic disciplines are sub-branches of mathematics. Perhaps we can put it another way: the laws of the world form a gigantic concentric mandala, like the Mayan calendar or like a pyramid seen from above, with mathematics as the central layer, physics the next, chemistry next, biology next, anthropology next, the arts and humanities next, and theology as the outward margin. To understand any layer profoundly, it is necessary to plunge into the discipline beneath it. This hierarchical structure is the dynamic residue of the actual process of evolution in its broadest sense: the evolution of coherent forms of energy out of the probabilistic chaos and mathematical constraints of the first nanoseconds of the Big Bang; the evolution of stable particles and then stable atomic structures as the universe cooled to the point where nuclei could retain electrons; the cooking up of the elements of the periodic table inside the cores of massive stars and the evolution of chemistry as local temperatures dropped below three thousand degrees; the evolution of life three and a half billion years ago, and the evolution of humankind in the last five million.

We can use our mandala as a diagram and scale of measurement for various important parameters. Most important, of course, it is a calendar, depicting the origin of the universe at the center —the Big Bang, which began in a state too small, hot, and brief in existence to allow the laws of physics to exist, and which can only be described in pure mathematics. As we move outwards, the emergence of physics, chemistry, biology, the human world described by anthropology, and the civilized world of the arts and humanities follow in sequence. Our mandala is also a scale of size: the universe of the Big Bang was smaller than an atom, but as physics, chemistry and so on emerged, together with the more and more macroscopic entities they describe, it expanded to its present size. Our new Great Chain of Being is also the scale of thermometer: the universe began hot, and cooled as it expanded. It is also a measure of the increase of certain other important measures, some of them central to thermodynamics: entropy, negentropy, iterativeness of systemic feedback, and the complexity of time itself, as judged by the emergence of more and more subtle temporal sensitivities in the oscillatory repertoire of crystals and the sensoriums of bacteria, plants, and animals.



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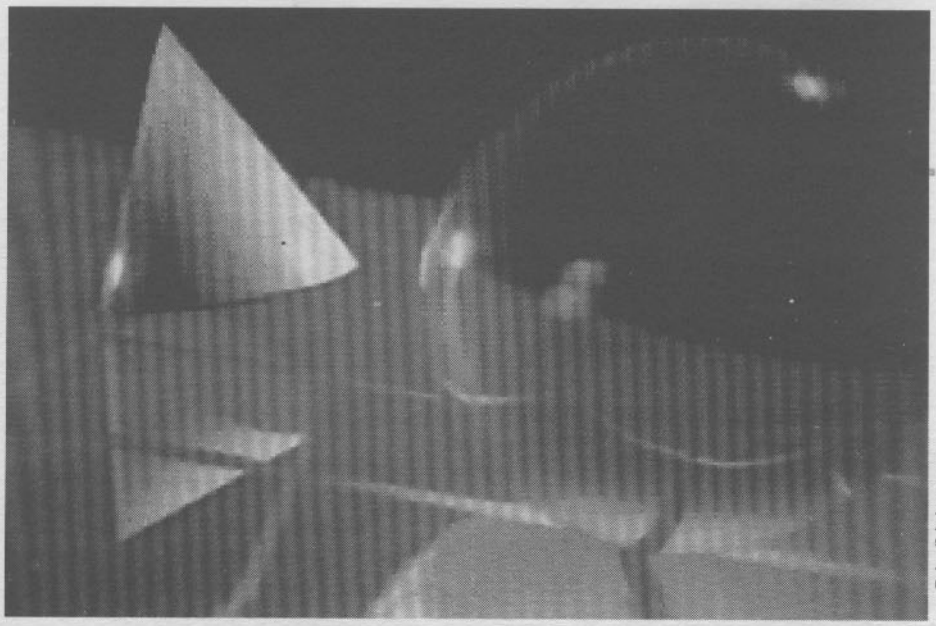
At each point in this development the universe leaped to new magnitudes of complexity and integrated organization. It would take an inconceivably greater number of bits of information to describe the current universe than to describe the universe of four billion years ago, and that universe would in turn take many more bits than the incandescent universe of the Big Bang. There is not enough computing power in the universe to give a complete mathematical account of a complex biological or social system, even though their microstructure is mathematical. The further back we go, the fewer physical laws there were, and the simpler the universe. In a sense, the Big Bang universe is still with us as a kind of living fossil, exemplified in the probabilistic and indeterminate interactions of the smallest known physical particles. But at one time that was all there was, and there would have been no need for the laws of chemistry, biology, and so on.

When we consider the contemporary natural and human sciences as a whole, what emerges is a remarkable vision of the universe



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and its history. This vision will, I believe, serve the same function with respect to twenty-first century humanity that the great chain of being did for the high middle ages and the renaissance: a way of connecting cosmos and psyche, of ascertaining and generating value, and of guiding creative action and innovation. It will also allow us to place any local event or individual phenomenon within a global frame.

Though the comparison with the Great Chain of Being is a valid one in some ways, there are immense differences between the emerging new synthesis and the old. First, and most important, the new synthesis is essentially dynamic, changing, evolutionary, historical, and irreversible, while the old was static, unchanging, creationist, eternal, and cyclic in its temporal manifestation. In the new synthesis (which we might as well call the evolutionary synthesis) new realities —new species, for instance— can emerge, whereas in the old Aristotelian-Thomistic system species, or kinds of things living or unliving, are eternal categories, which their temporal exemplars or avatars in the material world strive without full success to fulfil and accomplish.

The second major difference is that the old synthesis works through a fundamentally top-down causality and ordering process, whereas the new synthesis, at least in its early stages, is largely bottom-up in its causality and ordering. In the Thomist universe God created and ruled the angels and human beings, who themselves ruled over the animals, which in turn were given domain over the plants, which controlled their inanimate material food, and so on down. In the evolutionary universe the sequence is reversed: the laws and particles of physics largely determine the ground-rules of chemistry, which provides the arena for life, which in turn produces and generates conscious minds.

However, in the new synthesis, bottom-up material determinism, operating through the variative/ selective process of evolution, paradoxically brings about organisms which, as wholes, determine themselves and their inner and outer environment as much as or more than they are themselves determined. Our minds make decisions that alter the state of our muscles and other organs, which in turn govern the cells, molecules, atoms, and subatomic particles within them. Thus in the new synthesis a top-down, whole-to-part creative ordering can exist, though it must first be brought into the world, and must continually be maintained, by a bottom-up, part-to-whole evolutionary or metabolic process. Together, then, in the evolved state of the world, bottom-up and top-down causality cooperate in a complex feedback system which is capable of further self-elaboration into yet more reflexive states of being.

The last major difference between the old Great Chain of Being and the new evolutionary universe is that whereas the former requires an outside creator and arranger, the former is self-creating and self-organizing. The old worldview provides an eternal transcendent God radically separated and distinguished from His creations by the fact that He alone is self-sufficient and self-creating. The new view, on the other hand, is approaching the position that the universe is a logical necessity; that is, the existence of a state of affairs in which nothing at all existed would require some extraordinary, ineffable and transcendent metaphysical intervention; but the existence of an evolving, self-organizing universe is essentially inevitable without such an intervention.

This view places the characteristics of loving fruitfulness, the apparent intention of design, and teleology, once postulated as necessarily belonging to the creator, in the creation itself, if they are

anywhere at all. Until a couple of decades ago it was assumed that the physical universe works deterministically, and so if we accepted the new view we were forced to assume that those *creatorly* characteristics were nonexistent, illusions imposed upon a blind and automatic universe by our animistic expectations. In other words our intellectual honesty required us to disbelieve our eyes and ears, which told us of the joy of creation as it sings itself into being. But now the new mathematics, physics, and chemistry of non-linear, irreversible, unpredictable dynamical systems show us that the physical universe is, in effect, free, and can thus be held responsible for its own beautiful order, richness, and creative innovation.

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There is an apparent contradiction between the idea that the universe was compelled to come into existence, and that it is free. But this contradiction is only apparent. Some kind of evolving, self-organizing universe is a necessity; but which one it is, how it evolves, which directions it takes are, so to speak, up to its own choice. And *choice* is really not a bad word at all to describe the way in which, as the new science has shown, complex and unstable dynamical systems, on the verge of some transformation and unable to hold their present arrangement intact (for instance, a hot but cooling universe of pure energy about to give birth to matter, or a supersaturated crystalline solution, or an ecosystem with more resources at its disposal than it is using, or a heart between beats), unpredictably *collapse* into one of a large number of possible new states. The collapse is unpredictable not necessarily because any of its contributing elements is disordered but because all of them are dependent on each other in a complex contextual feedback relationship, and must thus all change together, without a causal priority and sequence that can be analysed by any system smaller than the universe itself. The fact that this new state will fall within the parameters of a very beautiful and elaborate *strange attractor*, and not outside it, is an indication not of the lack of *choice* in this sense, but of its orderly coherency, its nonrandomness.

How did our new great chain of being come into existence? The most exciting mathematical ideas of our century deal with the incompleteness and open-endedness of any mathematical system, and its propensity to generate paradoxes which can only be resolved in terms of some richer and more reflexive system which includes it —a system which 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 the 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 which 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.

The new fractal geometry includes a working concept of how a given dimension can be generated, and coherent definitions of partial dimensions. We are familiar in

classical geometry with zero-dimensional points, one-dimensional lines, two-dimensional planes, three-dimensional volumes, and so on; popular science has invited us to imagine more dimensions still. But the non-integer dimensions of fractal mathematics —a given curve can have a dimensionality of 1.62, for instance— are a new concept, and show us how we might, through the feedback of an iterative algorithm, actually get from one integer dimension to another.

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 talk coherently about such distinctions, and to measure their differences, another kind of dimensionality is needed: time. 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, or infinitely; and if infinitely, which of Cantor's larger and larger infinities it would be.

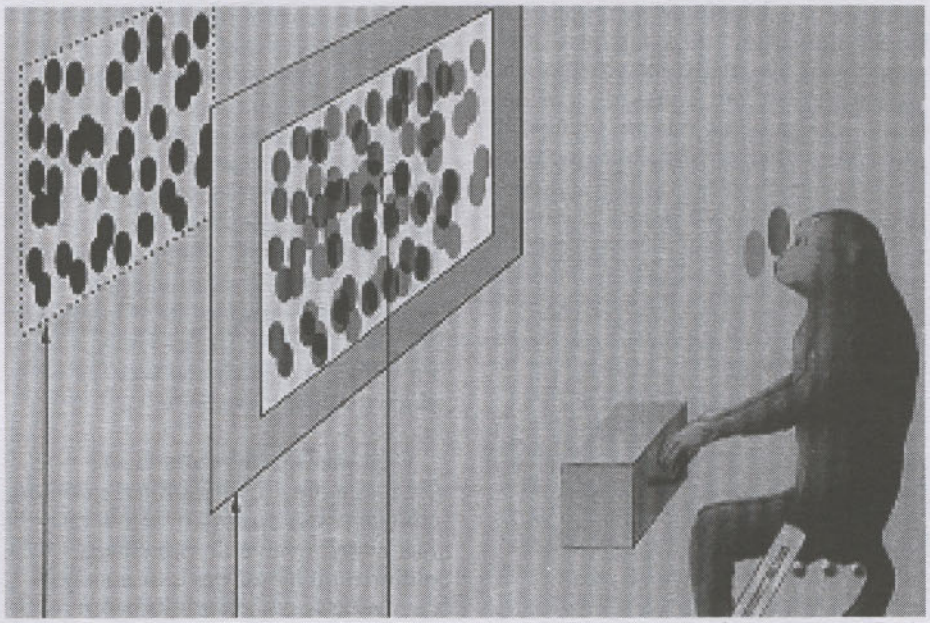
Thus spacetime emerges out of very logic; and given spacetime, theoretical and cosmological physics can show the necessity of the Big Bang. Once we have empty spacetime, we have the quantum vacuum, which immediately gives birth, so the quantum cosmologists tell us, to pairs of positive and negative energy particles. Energy emerges as the coherent solution of certain possible and necessary spacetime geometrical paradoxes, and energy collapses into matter, becoming bound by its own fields, as the universe cools with its expansion. Matter is the solution to paradoxes that arise in the energy universe as the primal superforce separated itself out into gravitation, electromagnetism, the weak and the strong nuclear forces.

We might add that 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.

Given matter, another open-ended process begins, of chemical recombination. 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

José Luis Hernández M.



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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.

With life a new element enters into 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.

Here there is a subtlety that escapes some evolutionary biologists, who instinctively distrust any suggestion of teleology in evolution. The point is this: if the genome and nervous system of a given species are sufficiently complex to support teleology and teleological motivations (even if very rudimentary ones, such as care of the young), and if a hypothetical species is more adaptive, and survives and reproduces more successfully, when it acts as if it possessed teleological goals, then variation could bring about such a species, and once it did, selection could help it to spread. In order to compete with such a species, other species would need to develop the same talent, of acting (and thus being motivated to act) as if there were teleological goals. (In just such a fashion the indicative mood of the real number series demands and implies the subjunctive mood of the imaginary number series). After a rather brief interval of evolutionary history it would be very hard to tell whether one were living in a teleological universe, striving to become more advanced and sensitive and self-aware and concerned with the future, or whether the world around one were simply acting as if this were the case. And for a scientist such a difference should really be of no concern, though it might be distressing to a philosopher.

But 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 at least a hundred thousand years for a 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 which 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.

Of course, the irony of this process is that the paradoxes get more complex with each new solution of them; and the human paradoxes, summed up in the word *shame*, 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 shame, or in fashionable cynicism, condemned the human species and its progress, have not reflected that in a sense the shame of things goes all the way back: shame is most primitively the paradox of self-inclusion. If they would turn back the clock and abolish humankind, 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?

Priss/Linies

Value evolved slowly in the universe, increasing with each access of reflexivity and level of feedback, complex entities conferring value upon each other and upon the less complex by sensitively registering their presence, perceiving, eating, mating with, desiring, or loving them; and conferring value upon themselves by their increasingly intentional and planned attempts to survive and reproduce. More intense and more universal values evolved with increasing ecological interdependence, whether among whole populations of species or in those fantastically complex and swiftly-evolving inner ecologies, the nervous systems of higher animals.

Between the collapse of the old great chain of being and the rise of the new there fell a period in which no coherent intellectual structure existed for assigning to things the value we instinctively know they hold. Though the social and economic changes that destroyed the old value-giving rituals were the main cause of this crisis of value, part of the credit must go, paradoxically, to the very success of the physical sciences, which, as we can see clearly in the Novum Organon of Bacon, had had at their outset to fight for their very existence against rigid traditional codes of value. Science adopted a *value-free* ethic which worked very