1 On Beauty

What is beauty? The very concept is rejected by many contemporary artists and estheticians.

Part of our predicament is that the arts have been cut off from the sciences; cut off, that is, from any coherent and well-founded and *surprising* conception of the cosmos that we live in and of our own bodies and nervous systems. Thus a scientific answer to the question of beauty has been until recently unavailable to artists and estheticians. At the same time science itself has been until recently—though there are encouraging signs of change—fragmented, disunified, and mortally afraid of value questions. In practice all true scientists prefer beautiful scientific theories to ugly ones. But this aspect of science is a long way from the routine of institutionalized science and has seldom penetrated through to the arts.

Robert Pirsig put the matter thus:

> At present we're snowed under with an irrational expansion of blind data-gathering in the sciences, because there's no rational format for any understanding of scientific creativity. At present we're also snowed under with a lot of stylishness in the arts—thin art—because there's very little assimilation or extension into underlying form. We have artists with no scientific knowledge and scientists with no artistic knowledge and both with no spiritual sense of gravity at all. And the result is not just bad, it's ghastly. (*Zen and the Art of Motorcycle Maintenance,* p. 287)

That "spiritual sense of gravity" is close to what I mean by beauty; but to give this phrase some meaning we must pursue our first question without qualms that analysis will destroy it. Analysis could only destroy it if it had no concrete existence—which is what its critics claim, that beauty is an illusion in the

eye of the beholder, an eye preconditioned by social convention and economic interest. What this essay will do is argue that beauty is an objective reality.

If not beauty, what do contemporary artists propose to themselves as the meaning of their work? There are three usual answers to this question. The first is that it is enough to be new, disturbing, analytically interesting. If there is no further depth in a work of art, does not this boil down, honestly, to being what Pirsig calls stylish?—fashionable? Is not such art merely a sort of demonstration of critical ideas? The second approach is to be personal. In this view the work of art has a quality derived from the mysterious and intangible nature of the individual. But does not this answer simply shift the problem from what makes an engaging work of art to what makes an engaging human being?—all the self-expression in the world cannot make interesting a personality we do not like; indeed, quite the reverse. The third answer is that art should be socially, economically, and politically correct. There are many variations of this: Marxist art; the simulation of regional or vernacular art; the art of gender politics; functionalist art. But again the question is begged: if we cannot recognize a good work of art, how can we recognize a good society or economy or polity? Can art be subordinate to politics, and still be distinguished from propaganda? Why should not art be the free and vital source of political ideas, rather than their servant and vehicle? And is not functionalism merely a permit for art to be guided by unguided technology? These issues have been gone over in weary detail by much contemporary critical and esthetic theory; there is no need to dwell on them here, where much more exciting possibilities await us.

Let us return to the idea of beauty as the goal and meaning of art. But what is beauty in the most general sense? What nontrivial description could hold true for a beautiful Inuit mask, a beautiful man or woman, the laws of thermodynamics, an Arcadian landscape, a picture of an Arcadian landscape, a Bach canon, the Mandelbrot set (with its microcosmic corona of Julia sets), a flowering chestnut tree, the theory of evolution by natural selection, an African ritual dance, and Yeats's "Byzantium"?

All human societies possess the concept of beauty, often with a very precise vocabulary and a tradition of argument about it. People see (hear, touch, taste, smell) the beautiful, and recognize it by a natural intuition and a natural pleasure.

Even animals do: antiphonal birdsong, the brilliant shapes and colors of flowers (what more precise record could there be of the esthetic preferences of bees?), and the gorgeous ritual mating garments of tropical fishes and birds of paradise, all attest to a more than utilitarian attraction in certain forms of organization.

This "natural intuition" is for us human beings activated, sensitized, and deepened by culture; that is, a natural capacity of the nervous system now incorporates a cultural feedback loop, and also uses the physical world, through art and science, as part of its own hardware. The theory of such a training or sensitization, the incorporation of this cultural feedback loop, the plugging of it into the prepared places in our brains, is what I call "natural classicism." In a previous book by that title much of the evidence for the following ideas is cited; the task here is not to prove its contentions, but to explore its further implications.

The foundation of the natural classical perspective is that the universe, and we, evolved. This fact entails two truths about beauty: a special evolutionary truth and a general evolutionary truth.

The special evolutionary truth is that our capacity to perceive and create beauty is a characteristic of an animal that evolved. Beauty is thus in some way a biological adaptation and a physiological reality: the experience of beauty can be connected to the activity of actual neurotransmitters in the brain, endorphins and enkephalins. When we become addicted to a drug such as heroin or cocaine we do so because their molecular structure resembles that of the chemistries of joy that the brain feeds to itself.

What is the function of pleasure from an evolutionary point of view? The pleasure of eating is clearly a reward for the labor of getting ourselves something to eat. Certainly few would go to the extraordinary metabolic expense and aggravation of finding a willing member of the opposite sex and reproducing with him or her unless there were a very powerful inducement to do so. We are presented with this very great pleasure of beauty, for which artists will starve in garrets and for whose mimicked substitutes rats and addicts will happily neglect food and sex. What is it a reward for? What adaptive function does it serve, that is so much more important than immediate nourishment and even the immediate opportunity to reproduce the species?

Freud claimed that the esthetic was merely a sublimated form of libido. But the new knowledge about neurotransmitters and brain reward renders this theory invalid. Beauty, it seems, has a perfectly adequate chemistry of its own, without having to borrow a bit of the pleasure-chemistry of sex. We must reexamine the whole relationship between the beauty that men and women find in each other and sexual desire. Could it not be that the truth is exactly opposite to what Freud thought?—that much of what we think of as sex is actually a relaxed or dissipated form of esthetic excitement; that sexual attraction is not enough by itself to assure the reproductive pair-bond, and that it must borrow—or sublimate!—part of the energy of spiritual experience! What might a psychoanalysis based on such ideas look like?

Let us return to the question: what is the beauty-experience a reward for? To answer this question we need to know a little about the timing of human evolution, as it is becoming clear from the work of paleoanthropologists, paleolinguists, archaeologists, and paleogeneticists. The crucial point is that there is a peculiar overlap between the last phases of human biological evolution and the beginnings of human cultural evolution, an overlap of one to five million years, depending on how the terms are defined. In any case, there was a long period during which human culture could exert a powerful, indeed dominant, selective pressure upon the genetic material of the species and thus upon the final form it has taken (if ours is the final form).

For over a million years the major genetic determinant in the environment of our genus was our own culture. A creature that is living under cultural constraints is a creature that is undergoing an intensive process of domestication. Consider wheat, dogs, apple trees, pigeons: how swiftly and how dramatically they have been changed by human selective breeding! But we domesticated ourselves. There is a limestone cave near Zhoukoudian in northern China where human beings lived almost continuously for close to a quarter of a million years. It is filled almost to the roof with eighteen feet of compacted human debris—ash, bedplaces, bones. At the bottom, the oldest layers contain great hamhanded hammerstones, cutting clubs with a shard knocked off for a blade, and the clumsy bones and skulls of Homo erectus. At the top, there are delicate leafshaped flint arrowheads, fine awls and augers, featherlike knives; and human jawbones made elegant by cookery, braincases made ample and capacious by ritual.

Imagine—and we hardly need to imagine this, for we have so many examples in our experience, if we could only see them as examples—imagine a mating ritual, which directly affects the reproductive success of the individuals within a species. Those who are neurologically capable and adept at the complex nuances of the ritual would have a much better chance of getting a mate and leaving offspring. Now imagine that this ritual is being handed down from generation to generation not just by genetic inheritance, but also, increasingly, by cultural transmission: imitation, instruction, and eventually language (did it evolve in order to facilitate this transmission?).

If a behavior is handed down purely by genetic inheritance, any variations on it which result from individual differences and special environmental and social circumstances will be wiped out by the death of the individuals of a given generation and will not be transmitted to their offspring. Of course if over thousands of years those individual differences lead to improved rates of survival, and if those special circumstances persist, then there may be a selective advantage in the behavior as modified by the variation, and that variation will become frozen into the genes. But this is a very slow process: the learning is being done at the genetic level, not at the social or mental level.

But in the thought-experiment that we have commenced, changes in the ritual can be handed down very quickly, in only one generation; and so the faster system of transmission will tend to drive and direct the slower system of transmission. That is, cultural modifications in the ritual will tend to confer a decisive selective advantage upon those members of the species that are genetically endowed with greater neural complexity, a superior capacity for learning the inner principles of the ritual which remain the same when its surface changes, for following and extending the ritual's subtleties, and for recognizing and embodying the values that the ritual creates. Cultural evolution will drive biological evolution. This species, of course, is ourselves: perhaps what created us as human beings was an improved lovesong. In the beginning, indeed, was the word.

In this scenario the idea of beauty clearly has a central place. The capacity for recognizing and creating beauty is a competence that we possess, a competence that was selected for by biocultural coevolution: it is both a power that the "mating ritual" of human and prehuman culture demanded

and sharpened, and a value generated by that ritual that it was in our reproductive interest to be able to recognize and embody. Such an analysis might well adjust the balance of traditional paleoanthropology, which has been perhaps excessively concerned with with hairy males with flint axes, and begin to provide, if not a feminist anthropology, then a human one. To be, and to be able to recognize, a beautiful human being, and to desire to mix one's seed with his or hers, might be a survival strategy that drove the flowering of Homo sapiens. Already some of our examples of beauty—the man and woman, the Inuit mask, the African dance at least, and perhaps several of the others—might begin to fit together under a reasonably rich description.

What are the results of this coevolution in the neurobiology of esthetic experience? Simply to be able to ask this question—that it should be reasonable, indeed predicted by a solid theory, for beauty to have a pancultural neurobiological base—overturns modernist and most postmodernist esthetics. The evolutionary perspective suggests that we have inherited a number of related natural-classical genres or systems by which we generate, recognize, and appreciate beauty. What are these genres?

The experimental neuropsychologist Ernst Pöppel and I have investigated one of them in some detail—poetic meter, or what we have called the neural lyre. All over the world human beings compose and recite poetry in poetic meter; all over the world the meter has a line-length of about three seconds, tuned to the three-second acoustic information-processing pulse in the human brain. Our acoustic present is three seconds long—we remember echoically and completely three seconds' worth of acoustic information, before it is passed on to a longer-term memory system, where it is drastically edited, organized for significant content, and pushed down to a less immediate level of consciousness.

If a natural brain rhythm, like the ten cycle per second alpha rhythm—or the three second audial present—is "driven" or amplified by an external rhythmic stimulus, the result can be large changes in brain state and brain chemistry, and consequently in the amount and kind of information that the brain can absorb, and in the kind of higher-level processing it can put to work.

We showed that in addition to these effects, poetic meter contained within the line a regular pulse of syllable-patterns,

made of heavy and light, long or short, tone-changing or unchanging, against which significant and expressive variations could be played. For instance, the English iambic pattern consists of a regular pulse of one unstressed and one stressed syllable, thus: -/ . But consider this stanza from Yeats's "Byzantium," which is based on the same iambic (-/) pattern of syllables, yet varies freely on it without losing touch with it:

/ - - / - / - / - -
Miracle, bird, or human handiwork,
/ / - - - / - / - -
More miracle than bird or handiwork,
/ - - - / - / - /
Planted on the starlit golden bough,
/ - - / - / - /
Can like the cocks of Hades crow,
/ - - / - / - / - /
Or, by the moon embittered, scorn aloud
- / - - / - / -
In glory of changeless metal
/ - / - / -
Common bird or petal
- / - / - - - / - /
And all complexities of mire or blood.

The difference between the expected rhythm and the actual rhythm carries information, as a tune does, or as a line does in a drawing; and that information is processed and understood not with the linguistic left brain, but with the musical and spatial right brain. Thus, unlike ordinary language, poetic language comes to us in a "stereo" neural mode, so to speak, and is capable of conveying feelings and ideas that are usually labeled nonverbal; the genre itself is a biocultural feedback loop that makes us able to use much more of our brain than we normally can.

We need not go into this kind of detail with the other genres, but they show the same kind of fascinating interplay between inherited biological and learned cultural factors. Let us just list a few of them.

1. The metrical "operator" of music, which is related to but different from the poetic metrical operator, and which also connects with dance. It is very highly developed in African drum rhythms.

2. The reflexive or dramatic operator, by which we are able to simulate other people's consciousness and point of view in imaginative models (containing miniature models of the other person's model of us, and so on), and set them into coherent theatrical interaction. "O wad some pow'r the giftie gie us," says Robert Burns, "To see oursels as others see us!" This natural-classical genre does exactly that.

3. The narrative operator, that genre by which we give time a complex tense-structure, full of might-have-beens and should-be's, conditionals, subjunctives, branches, hopes, and memories. Fundamentally the narrative operation constructs a series of events which have the curious property of being retrodictable (each one seems inevitable once it has happened) but not predictable (before it happens, we have no sound basis on which to foretell it); which is why we want to know what happens next. This operator comes with a large collection of archetypal myths and stories, such as the Swan Princess, which are fundamentally identical all over the world, because their seeds are in our genes.

4. The color-combination preferences that are associated with the so-called color wheel.

5. A similar visual detail-frequency preference system, which makes us prefer pictures and scenes with a complexly balanced hierarchy of high-frequency information (dense textures and small details) ranging through to low-frequency information (large general shapes and compositions). Consider, for instance, Japanese prints, or the Arcadian landscape paintings of Poussin and Claude.

6. A representational operator (unique to human beings), whereby we can reverse the process of visual perception and use our motor system to represent what we see by drawing, painting, or sculpting.

7. Musical tonality and the inexhaustible language it opens up, from Chinese classical music, through Balinese gamelan, to the fugues and canons of Bach.

And many more. Researchers of great boldness and brilliance are working to clarify the neuropsychology and anthropology

of these systems; their results so far are described in a recent book entitled *Beauty and the Brain.*

As yet this list is just a list, with no systematic classification and no attempt to organize its members according to criteria of greater or lesser neural generality. But it does indicate that the forms of the arts are not arbitrary, but are rooted in our biological inheritance. To say this is not to imply that the natural-classical genres are constraints, or limits upon the expressive powers of the arts. Quite the reverse; they are like what computer enthusiasts call turbos—programs or hardware that can accelerate and improve the operation of a computer. These systems, which incorporate a cultural feedback loop into the brain's processing, can enormously deepen and broaden its powers. Language itself may be one of the most comprehensive and earliest of them. They are not constraints any more than the possession of a hammer or a screwdriver is a constraint upon our carpentry; but their use must be learned. An esthetic education that assumes that genres are obstacles to creativity, and which thus does not bother to teach them, deprives our children of their inheritance.

So much for the special evolutionary truth about beauty. Without the general evolutionary truth, it would be meaningful only in a practical sense, it would leave out that tremble of philosophical insight that we associate with beauty, and would ignore the beauty that we find in nature and in the laws of science. It is not enough, from an evolutionary point of view, that individuals within a species should be endowed with a species-specific sense of beauty related to cooperation and sexual selection, even if the selection favors big brains, sensitivity, and artistic grace. The whole species must benefit from possessing a sense of beauty. This could only be the case if beauty is a real characteristic of the universe, one that it would be useful—adaptive—to know. How might this be?

What I want to suggest is that the experience of beauty is a recognition of the deepest tendency or theme of the universe as a whole. This may seem a very strange thing to say; but there is a gathering movement across many of the sciences that indicates that the universe does have a deep theme or tendency, a leitmotif which we can begin very tentatively to describe, if not fully understand.

Let us play with an idea of Kant's and see what we get if we treat the esthetic as something analogous to perception. Imagine dropping a rock on the floor. The rock reacts by

bouncing and by making a noise, and perhaps undergoes some slight internal change; we would not imagine that it felt anything approaching a sensation.

Now imagine that you drop a worm on the floor; the impact might cause it to squirm, as well as merely to bounce and to produce a sound of impact. The worm, we would say, feels a sensation; but from the worm's point of view it is not a sensation of anything in particular; the worm does not construct, with its primitive nerve ganglia, anything as complex as an external world filled with objects like floors and experimenters.

Now imagine that you drop a guinea pig. Clearly it would react, as the rock does, and also feel sensations, as the worm does. But we would say in addition that it perceives the floor, the large, dangerous animal that has just released it, and the dark place under the table where it may be safe. Perception is as much beyond sensation as sensation is beyond mere physical reaction. Perception constructs a precise, individuated world of solid objects out there, endowed with color, shape, smell, and acoustic and tactile properties. It is generous to the outside world, giving it properties it did not necessarily possess until some advanced vertebrate was able, through its marvelously parsimonious cortical world-construction system, to provide them. Perception is both more global, more holistic, than sensation—because it takes into account an entire outside world—and more exact, more particular, because it recognizes individual objects and parts of objects.

Now if you were a dancer and the creature that you dropped were a human being, a yet more astonishing capacity comes into play. One could write a novel about how the dance partners experience this drop, this gesture. Whole detailed worlds of implication, of past and future, of interpretive frames, come into being; and the table and the dancing floor do not lose any of the guinea pig's reality, but instead take on richnesses, subtleties, significant details, held as they are within a context both vaster and more clearly understood. What is this awareness, that is to perception what perception is to sensation, and sensation to reaction? The answer is: esthetic experience. Esthetic experience is as much more constructive, as much more generous to the outside world, as much more holistic, and as much more exact and particularizing than ordinary perception, as ordinary perception is than mere sensation. Thus by ratios we may ascend from the known to the very essence of the knower. Esthetic perception is not a vague and touchy-

feely thing relative to ordinary perception; quite the reverse. This is why, given an infinite number of theories that will logically explain the facts, scientists will sensibly always choose the most beautiful theory. For good reason: this is the way the world works.

Beauty in this view is the highest integrative level of understanding and the most comprehensive capacity for effective action. It enables us to go with, rather than against, the deepest tendency or theme of the universe, to be able to model what will happen and adapt to or change it. Such benefits might well be worth the enormous metabolic expense of the brain, that organ that spends a third of the body's oxygen and sugar, and for which the body will willingly sacrifice itself.

But this line of investigation has clearly brought us to a question which it seems audacious to ask in this antimetaphysical age. Let us ask it anyway: what *is* the deepest tendency or theme of the universe?

Let us make another list, a list of descriptions or characteristics of that theme or tendency. We can always adjust or change the list if we want.

1. Unity in multiplicity—the universe does seem to be one, though it is full of an enormous variety and quantity of things. Our best knowledge about its beginning, if it had one, is that everything in the universe was contracted into a single hot dense atom; or if it had no beginning, then it is bounded by a single space-time continuum out of which all forms of matter and energy emerge.

2. Complexity within simplicity: the universe is very complicated, yet it was generated by very simple physical laws, like the laws of thermodynamics.

3. Generativeness and creativity: the universe generates a new moment every moment, and each moment has genuine novelties. Its tendency or theme is that it should not just stop. As it cooled, it produced all the laws of chemistry, all the new species of animals and plants, and finally ourselves and our history.

4. Rhythmicity: the universe can be described as a gigantic, self-nested scale of vibrations, from the highest-frequency particles, which oscillate with an energy

of ten million trillion giga-electron volts, to the slowest conceivable frequency (or deepest of all notes), which vibrates over a period sufficient for a single wave to cross the entire universe and return. Out of these vibrations, often in the most delicate and elaborate mixtures or harmonies of tone, everything is made.

5. Symmetry: shapes and forms are repeated or mirrored in all physical structures, whether at the subatomic, the atomic, the crystalline, the chemical, the biological, or the anthropological levels of reality. And the more complex and delicate the symmetry, the more opportunities it presents for symmetry-breaking, the readjustment of the system toward a new equilibrium, and thus adaptation toward even more comprehensive symmetries.

6. Hierarchical organization: big pieces of the universe contain smaller pieces, and smaller pieces contain smaller pieces still, and so on. Relatively big pieces, such as planets and stars, control to some extent—through their collective gravitational and electromagnetic fields—the behavior of the smaller pieces of which they are composed, while the smaller pieces together determine what the larger pieces are to begin with. We see the same hierarchical organization, much more marvelously complex and precise, in the relationship of the smallest parts of the human body to the highest levels of its organization, from elementary particles through atoms, molecules, cells, organelles, and organs, to the neural synthesis that delegates its control down the chain. Consider also the elegant hierarchy of support, control, cooperation, and dependency that one finds in the parts and whole of a Bach canon.

Of course this hierarchy is also complicated and "tangled," as Douglas Hofstadter puts it, by the mutual interference of entities at different levels of it, and by systemic transformations; an ecology, a food chain, is always changing, even if very slowly. But if such disruptions overwhelm the hierarchical frame, then the system as a whole has died, and its elements can then identify themselves only as a part of some other, perhaps cruder, hierarchical system. Thus the cells of my muscles when I am dead no longer obey my nervous

system, but are either commandeered by the organization of worms and bacteria, or become part of the even more primitive systems of organic chemistry or physics.

7. Self-similarity: related to the hierarchical property is a marvelous property now being investigated by chaos theorists and fractal mathematicians: the smaller parts of the universe often resemble in shape and structure the larger parts of which they are components, and those larger parts in turn resemble the still larger systems that contain them. This property is in fact a kind of symmetry, but a symmetry not in different directions but on different scales. The scaling element makes an important difference, for the symmetry of form does not exist between two elements that are spatially separated from each other; one element is part of the fine structure of the other and can therefore interfere with it in a creative way. Thus the symmetry of self-similarity is a very rich field for the kind of symmetry-breaking which can generate new symmetries, new hierarchies, new beings.

   Like Dante's *Divine Comedy,* in which the three-line stanza of its microcosm is echoed in the trinitarian theology of its middle-level organization and in the tripartite structure of the whole poem, so the universe tends to echo its themes at different scales, but with variations and interferences that give life to the whole. If you look at the branches of a tree (Yeats's chestnut tree, perhaps, that "great-rooted blossomer") you can see how the length of a twig stands in a similar—but not quite the same—relation to the length of the small branches as the small branches stand to the large branches, and the large branches to the trunk. You can find this pattern in all kinds of phenomena—electrical discharges, frost-flowers, the annual patterns of rise and decline in competing animal populations, stock market fluctuations, weather formations and clouds, the bronchi of the lungs, corals, turbulent waters, and so on. And this harmonious yet dynamic relation of small to large is *beautiful.*

Now these descriptions would be immediately recognized by scientists in many fields as belonging to feedback processes and the structures that are generated by them. Indeed, it is

often difficult to tell the process apart from the product: how can we tell the dancer from the dance? *The fundamental tendency or theme of the universe, in short, is reflexivity or feedback.* We are beginning to understand more and more clearly that the universe is a phenomenon of turbulence, the result of a nested set of feedback processes. Hence, it is dynamic and open-ended: open-ended, moreover, precisely in and because of its continual attempt to come to closure, to fall to a stop. Moreover, as with any dynamic nonlinear open feedback process, the universe continually generates new frames and dimensions, new rules and constraints, and its future states are too complicated to be calculated by any conceivable computer made out of the universe as it is. It is retrodictable but not predictable, like a good—a beautiful—story.

In other words, the universe is what we call *free.* We human beings possess a larger degree of freedom, perhaps, than any of the other parts of the world, but we are not unique in being free, even in a very powerful sense of the word. If we could isolate any part of the universe—which is the aim of a good laboratory experiment—then we might be able to create small pockets of determinism: planetary orbits are one example of a sort of natural isolated experiment of this kind. But even here both the microcosm—quantum uncertainty—and the macrocosm—the gravitational influence, however weak, of distant stars—will create a margin of irreducible error.

The process of evolution itself is a prime example of a generative feedback process. Variation, selection, and heredity constitute a cycle, which when repeated over and over again produces out of this very simple algorithm the most extraordinarily complex and beautiful lifeforms. Variation is the novelty generator; selection is a set of alterable survival rules to choose out certain products of the novelty generator. And heredity, the conservative ratchet, preserves what is gained.

But evolution is only one of a class of processes that are characterized by various researchers in various ways: nonlinear, chaotic, dissipative, self-organizing. They are based on very simple iterative formulae. The Mandelbrot set is a nice mathematical example: take a complex number; multiply it by itself; add the original number; then take the number that you get and repeat the process several times. Now start with a different number, and do the same thing. Make a collection of original numbers, and then map them on a plane, coloring

them according to whether, and how fast, the algorithm makes them rush off toward infinity, or zero in on some limit, called an attractor. (This is best done on a computer, because it would take many years to do it with paper and pencil.) You will get a self-similar shape of great beauty and infinite complexity and variety.

All such processes produce patterns with the familiar characteristics of branchiness, hierarchy, self-similarity, generativeness, unpredictability, and self-inclusiveness. To look at, they are like the lacy strands of sand and mud that Thoreau observed coming out of a melting sandbank in *Walden;* they are filled with lovely leaf designs, acanthus, chicory, ferns, or ivies; or like Jacquard paisleys, the feathers of peacocks, the body-paint or tattoo designs of Maoris or Melanesians, the complexity of a great wine, the curlicues of Hiroshige seafoam or Haida ornamentation or seahorses or Mozart melodies.

The iterative feedback principle which is at the heart of all of these processes is the deep theme or tendency of all of nature—nature, the creator of forms. It is the logos and eros of nature; and it is what we feel and intuit when we recognize beauty. Our own evolution is at the same time an example of the principle at work, the source of our capacity to perceive it in beautiful things, the guarantee of its validity (if it were not valid we would not have survived), and the origin of a reflective consciousness that can take the process into new depths of self-awareness and self-reference. As the most complex and reflexive product of the process that we know of in the universe, we are, I believe, charged with its continuance; and the way that we continue it is art.

What will the art of the future be like? Of course, one can only speculate. Perhaps the greatest challenge to the artist—as to the scientist, though I believe they will be harder and harder to tell apart—is the creation of artificial intelligence. Once we take this up as an artistic project it may well appear to us that artificial intelligence already exists on the level of software: traditional works of art are artificial intelligence software, designed to be run on meat computers, and generating an intelligence different from and beyond that of the unaided brain. When I look at a Cézanne or listen to a Bach fugue or read a Yeats lyric—or even more powerfully when as an actor or reader I become Falstaff, Hamlet, or Madame Bovary—my brain tissue becomes inhabited by something autonomous, personal, and creative that it could not have conceived alone.

In the future the wheel may come full circle, and we may be able to build into a connection machine or artificial neural network the very processes that characterize the human mind: unpredictable self-elaboration and self-organization, evolutionary selection of hypotheses in an ecology of competing neural connectivities, and the use of the outside world through sensation, memory, and action as a stable database and a hardware of calculation. This further step of evolution would not be something other than ourselves, it would *be* ourselves, would be the Son of Man—the daughter of humanity—toward whom we have yearned unaware for so long. She would be so beautiful; she would be like Rilke's angels, like Blake's joyful deities. Of couse this is dangerous thinking; but it is always dangerous to have a child, to give ourselves away to a future that we hope will be better than ourselves. How could we possibly deny our generosity?