Aesthetics and the Right Answer

Frank Oppenheimer, Exploratorium
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At the Exploratorium, selected artists collaborate with museum staff to produce artworks that are somehow linked to the museum's more didactic exhibits. At a reunion of the artists who had participated in this program, Frank commented, "Art is very much an integral part of what we want people to experience here. If you're going to know about nature, you have to know about how people react to and feel about nature. I think that's what artists communicate. " In this article published in The Humanist, March/April 1979, Frank describes some of the similarities between artists and scientists and some of their differences.

Students in physics courses spend a large fraction of their efforts in solving problems and finding the "right answer." The backs of most textbooks list the right answers for even-numbered problems, and the students feel guilty and stupid if they cannot find the right answers for the odd-numbered ones. In general, physics is considered a "right answer" subject. Its metaphysical implications are widely ignored along with the creative nature of scientific activity

Students in art classes, on the other hand, although encouraged to be inventive, are rarely aware that artists also find the "right answers." In fact, in the popular view, no one looks to art to provide any answers at all.

Art and science are very different, but they both spring from cultivated perceptual sensitivity. They both rest on a base of acute pattern recognition. At the simplest level, artists and scientists alike make it possible for people to appreciate patterns which they were either unable to distinguish, or which they had learned to ignore in order to cope with the complexity of their daily lives. One can look at

Artist Bob Miller drilled various sized holes in a board and then passed dispersed sunlight from his sculpture “Sun Painting” to create this portrait.

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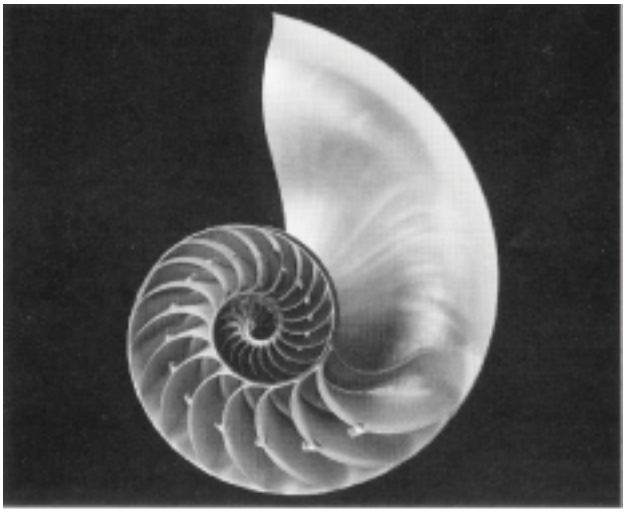
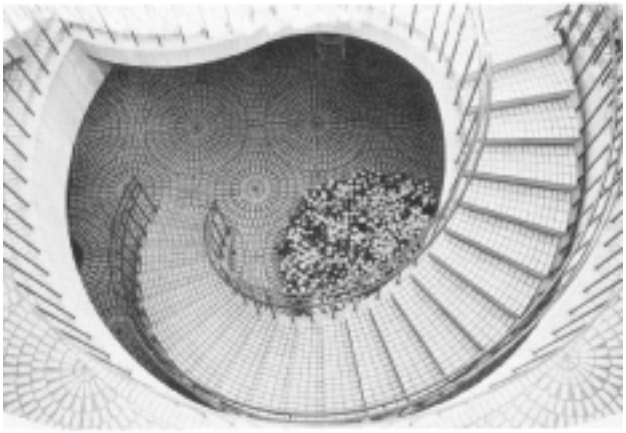
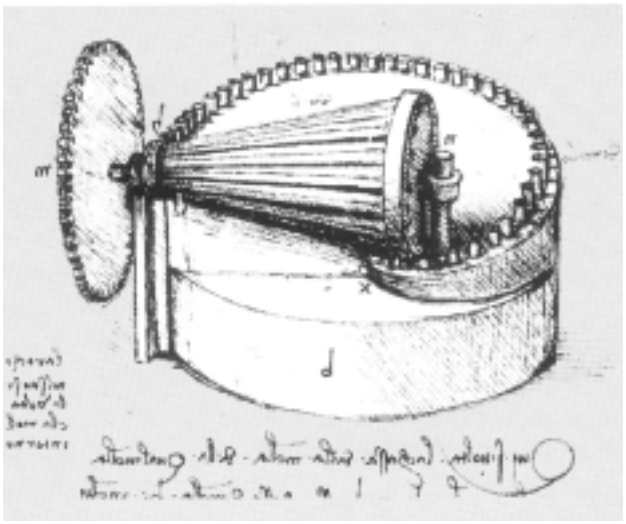
hills without noticing that they have a shape until a Cézanne becomes preoccupied with the form of Mont St. Victoire. One can see only a bland flesh color in faces until a Rouault makes one aware of the violent blues and reds and purples that actually appear. Similarly, one can observe the planets rise and set without becoming aware, as Kepler did, that they are moving in ellipses about the sun. One can watch falling bodies without sensing, as Galileo did, that they increase their speed by equal amounts in equal time intervals. Darwin and







Faraday, Freud and Marx, as well as Bach and Webern, Giotto and Klee, Shakespeare and Pinter, have all sensitized us to patterns which we might otherwise have missed

Many artists' sketches, as well as many sketchy reports in the Physical Review, simply portray or describe a newly discerned pattern. Even at this level they are important because people rely so heavily on pattern recognition in their personal and social lives. However, artists and physicists do more than discern and record patterns. They use perceived patterns to create additional patterns that are not directly derived from sensory perception. It is as though there were a second level of the neuromuscular system which had the ability to scan the patterns stored in the primary level by means of some, as yet unrecognized, neural mechanism. Eyes and ears enable us to absorb and store the patterns of shape and time that are embodied in our experience. A higher level of perception becomes aware of patterns among these stored patterns. We develop patterns of patterns (called theories in physics, or compositions in painting or music) by selecting from the multitude of stored experiential patterns those which somehow, and often surprisingly, appropriately fit together. It is such patterns of patterns that reveal new insights. It is on this higher level at which we create symphonies from melodies, paintings from sketches, and broad physical theories from empirical summaries or "laws."

These patterns of patterns - the compositions, theories, and works that are assembled by artists and physicists - constitute their most important endeavors. They create an ever-broader framework and mapping of reality; they reassure by creating order out of confusion, separating relevancies from trivialities; they provide a framework for memory, enabling one to reconstruct the experiential patterns without requiring that the infinity of them be stored in memory. By enabling people to share experiences they can also, conceivably, make complex societies livable. But how do we judge their validity?

In physics, experiential patterns, empirical laws, become validated insofar as they are reproducible and communicable. There is, however, an even more powerful criterion. Their validity is recognized because they have been formulated in ways that suggest how they can be coalesced and synthesized into patterns of patterns. Experiential patterns that

describe the flow of heat, or the bending of light in glass have been variously described by physicists at one time or another. Some of these descriptions have led to an ever-expanding linking of patterns, more transparently than have others; they are thereby considered more valid than those which do not lead the way to new insights. It is in this sense that the Copernican pattern for planetary motion is more valid than the Ptolemaic. Both versions describe the motions accurately; both are reproducible and communicable, but Newton would scarcely have been able to produce a theory of gravitation had he been stuck with Ptolemaic epicycles rather than Keplerian ellipses. The distrust which physicists express for the occult stems from the fact that each described occult pattern stands by itself as an isolated kind of event, defying any possible integration of conjoining with other patterns to form a recognizable pattern of patterns.

Scientists not only concentrate on perceiving patterns, but they continually transform and reformulate them, or redetermine what aspects of a pattern they consider "signal" as opposed to "noise." Eventually some particular formulation becomes recognizable at the higher level of pattern recognition, and the creative work, once again, begins to move on.

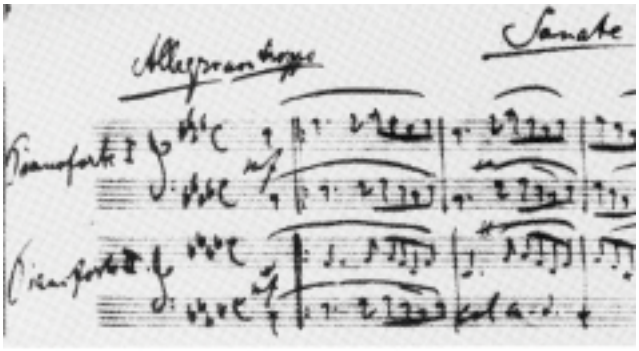
In physics, these patterns of patterns are selected as valid by using both aesthetic and correspondence criteria. Theories that are structurally simpler and that at the same time include more elements of the primary pattern are chosen. They appear more elegant. Maxwell, for example, created a truly elegant pattern of patterns which included virtually everything that had been observed about electricity and magnetism

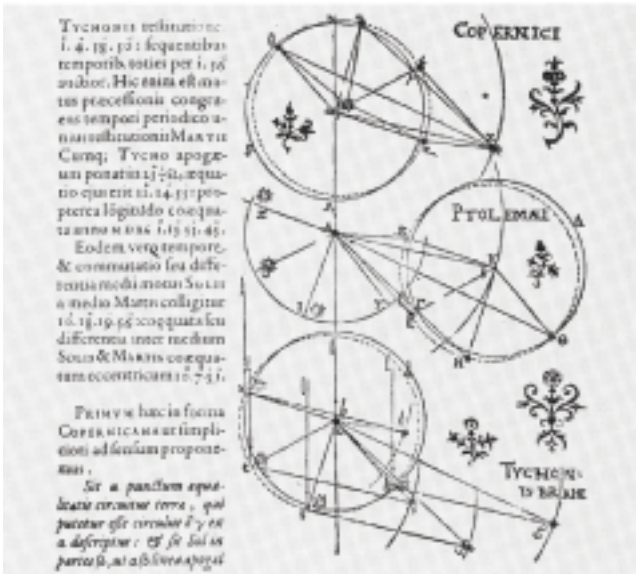
But a theory such as Maxwell's may have blank spaces, as though it were an assembled jigsaw puzzle in which everything fit, but in which there were still some holes. Holes could mean that the puzzle was incorrectly assembled. But more commonly, the holes represent missing pieces; they suggest that if one looks in the box or in the trash basket or under the table, one will find the missing pieces. One keeps looking and looking, and if one finds the missing pieces, one is convinced that the puzzle was assembled correctly. It is validated. However, if, as quite frequently happens, the search enables one to find too many pieces, one is forced to assemble the puzzle over again. The theories of physicists are obviously not framed by neat, rectilinear borders as are the puzzles bought in a store. Physical theories usually have boundaries with the jagged jigsaw shapes exposed, and which occasionally enable one to join two independently assembled puzzles. Actually, the imagery of a jigsaw puzzle is misleading. In the composite pattern of patterns of a physical theory, the pattern of individual pieces is not apparent. The composite is not necessarily representational. One has only an idea and a few equations which are less like a jigsaw puzzle than like a group of chromosomes containing all the information in some coded form which, through appropriate transformations, can represent each of the patterns incorporated into the theory. Newton's expression for gravitation, Maxwell's set of five equations, Dirac's quantum mechanics, or even the familiar $E = mc^2$, constitute such coded patterns of patterns. One considers them valid because they represent so much of what has been observed and because they keep leading us to new parts of reality.

The primary-level patterns that artists perceive do not necessarily stem from a different source than those that intrigue physicists. They involve shape, sound, light, motion, and an ever-increasing range of natural phenomena; but the process of formulation, representation and abstraction of these patterns by the artist differs from that by the physicist. The physicist represents patterns in a way that will facilitate his particular way of synthesizing patterns of patterns, often relying on mathematics, which is a step by step procedure to discover whatever elements fit together.

Great works of art also constitute a synthesis of experiential patterns and involve a process of selection. Some things fit together, and

others must be excluded from the composition. Sometimes the fit is recognized by established rules of form and structure, but usually there are no formulated rules and the synthesis is holistic and intuitive, but far from arbitrary. The artist, consciously or unconsciously, decides that some things are mistakes and must be done differently. The sure hand of Picasso or of Fermi makes few mistakes, but, more commonly, constant decision-making and choosing between alternatives is a characteristic of both artistic and scientific endeavors. The patterns of patterns created by artists are deemed valid, as are physical theories when, often after many false starts, they succeed in concordantly combining the multiple elements of nature and experience. Artists as well as scientists must transform or reformulate observed patterns in order to be able to perceive this concordance. Both artist and scientist combine elements of experience which no one else had conceived of as belonging together.





The works of artists are valid because they lead, as do physical theories, to the revelation of things that are happening, but which have not previously been perceived. In art, these revelations frequently apply to relationships and feelings within ourselves, to those patterns which involve a sense of order and disorder, or feelings of peace and anxiety, or even meaning and purpose, the introspective parts of reality. These relationships are not contained in Maxwell's or Dirac's equations, but they are not forbidden by them. Works of art not only enable people to form associations among previously experienced feelings, but they also generate new feelings from the juxtaposition of familiar ones.

Artists and scientists can observe the same patterns, but they frequently arrive at complementary syntheses of them. Most of us, for example, were intrigued as adolescents by the thought that love was merely endocrine chemistry. Certainly the poetic and the chemical descriptions of love refer to the same reality, but endocrine chemistry and falling in love cannot be bridged by any overlapping set of perceptual experiences. The appropriate starting point for the model must be determined by the way in which a question is formulated. In general, the renditions of art and science share this complementarity. Within this framework, the confirmed emotional revelation of artistic composition establishes validity just as surely as the revelations of theories in physics. Both are surely required to fully know nature.

The validity of art arises because through it we can recognize the way in which all the processes of nature, including those that arise within ourselves or that stem from other people, affect our consciousness and our emotional well-being. Art is not valid merely to decorate our surroundings with statues in the plazas of skyscrapers, any more than science is valid because it provides the conveniences of electric shavers. Surely they must both be 'required if we are to learn how to survive in a changing world - a world that we ourselves keep changing, but that would also change even if we were not here.