THE COMPLEMENTARITY OF ART AND DESIGN

Tsion Avital

Holon Institute of Technology
Faculty of Design
P.O.B 305, Holon 58102, ISRAEL

E-mail: tsionavital@bezeqint.net

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The many theories that have emerged over the course of the long history of aestheics have in fact contributed to a certain understanding of a few aspects of art, but no theory has succeeded yet in presenting a system of criteria that will allow the clear and persuasive determination of the demarcation lines between art and non-art. This unfortunate fact is not only the central cause of the confusion and anarchy pervading the art of our century; it is also the main reason for the current confusion between art and design. It is my aim to eliminate this confusion as far as possible, while not attempting to solve the formidable problem of demarcation1. Discussions of the relationship between art and design usually argue either that design is a kind of art and is therefore not distinct from it, or else that design is fundamentally distinct from art, making their linkage irrelevant. But a third position, the one taken in this essay, is that design is not only distinct from art, it is characterized by properties which are the exact opposite of the properties of art. Yet despite the contrasts between them, both art and design express two basic cognitive trends which are complementary components of human intelligence.

1. Design versus which Art?

If we are to clear up the confusion between design and art, design will of course have to be compared and contrasted with art. But there's a double question here: which design to compare with which art? The answer to the first question is simple and straightforward: design of any sort, industrial design, architecture, fashion design, ect. The answer to the second question is much more complex because in painting and sculpture today there are two totally different and opposed phenomena, both of which are called "art" even though one is the negation of the other. I am referring to figurative or representational art and what is called non-representational art. For

simplicity's sake I will use shorter terms to denote these two opposed conceptions in art: Realism and abstract art. This state of affairs naturally has implications for the question with which we must start: to which art should design be contrasted?

I propose that design be contrasted with figurative art or Realism, and not with abstract art. This decision is justifiable because logically it cannot be argued that Realism is not art, for Realism is the only historical and prehistorical sanction for the use of the term "art" in relation to painting and sculpture. Any attempt to claim that Realism is not art will necessarily be betrayed by an internal contradiction. By contrast, there is no logical self-contradiction in doubting the conventional designation today by which abstract art is considered art. Secondly, I do not propose to compare design to abstract art, because it is not possible to provide a clear specification of the works that ought to be assigned to this art. It is impossible to point to the necessary and sufficient conditions that make something a work of abstract art. The history of this art shows manifestly that everything, including nothing at all, may be accepted as a work of abstract art. Thirdly, the most profound difference between Realism and abstract art is that every figurative painting has a clear cognitive function, one of connection and classification.

A figurative painting is a pictorial connector or a pictorial universal, just like any concept in natural language. The same connective function is present in any concept, formula, number or pattern. That is to say, a figurative painting that depicts a horse does not depict a specific horse but depicts all horses of a certain kind, and the word "horse" does not denote any specific horse but denotes any horse. By contrast, no abstract painting is a pictorial connector because it does not serve as a pictorial label for any class of objects, concrete or abstract. On the contrary, it itself needs a verbal connector or verbal label to give it a name or meaning. A figurative painting is a symbol, part of a pictorial symbol system, and as such is a brain tool. An abstract painting, by contrast, is a result of atomization or fractionization of the traditional system of pictorial symbols, i.e., it is simply a perceptual phenomenon or an object. Within the context of this essay I have no intention nor pretense of refuting the view that abstract art is art. Such refutation would require an excursus that would take far from the framework of this essay. At this stage, however, all I want to argue is that there exists real legitimation for doubting the accepted view today that abstract art is art, and thus to justify the decision taken here to contrast design to Realism and not to abstract art.

2. A Difference in Direction: Up versus Down the Cognitive Ladder.

By way of generalization it can be said that the comparison between art and design reveals not only two fields between which there is no meaningful overlap, but also that these fields belong to logical types of different levels. To make the difference between art and design as pronounced as possible I will first stress the polarization characterizing the central tendencies of each of these two realms of human activity, and only afterwards will I show where the connection between them is to be found . Just as the evolutionary connections between design and art were already established in the furthest reaches of human evolution, so too were the profound differences between

them. I therefore propose beginning there, at the beginning. The most conspicuous difference immediately evident there is that between the designer as toolmaker and the artist as notator. Evolution required two to three million years to bring man from the one stage to the next. The ordinary use of stones to break something, or as a digging implement, and later the intentional selective alteration of the stone's shape to adapt it to its function, as a hand axe, for example, all represent extensions of the hand. Painting by contrast is an extension of the brain. The paintings on rocks and in caves were man's first attempts to preserve information outside his skull by means of symbolization or pictorial notation. They were the first attempt to build and preserve personal memory outside the organic brain, thereby transforming personal memory into a collective asset and collective memory.

A number of profound differences between the two domains follow from this difference. One of these domains is instrumental while the other is cognitive. One gives man a means for acting in the world, the other gives him a means for constructing reality itself through images, symbols, theories etc, and for constructing connections among the things in the world (things, the relations among them, and their meaning are all modes of connection in the world). One deals with the organisation of material and the articulation of objects, the other deals with the organisation of symbols and systems of symbols. One concretizes an image or symbol, the other symbolizes the concrete. One concretizes order, the other deals with invention, depiction, or the metaphorizing of relations of order. One effects changes in concrete states of affairs, the other effects changes in states of mind. One is intended for use, the other is intended for reading, communication and preservation of information. Or more generally, design moves from unity to multiplicity, from consciousness to reality, from the abstract to the concrete, from the general to the particular, while art and the other cognitive fields move in the very opposite direction.

These domains represent different and opposite directions of thought: the basic thought processes in design and technology are for the most part deductive, for they derive an object from an image, concept, plan, or theory. On the other hand, the mode of thought manifested in art is fundamentally inductive, classificatory, and generalizing. Already at this stage it is clear that the differences between design and art are in the broad sense the same differences as exist between design or technology on one hand, and science, philosophy or any other high level cognitive activity on the other .

The focus of comparison at this stage is the object as compared to the symbol. Objects are always discrete, specific particulars, which are not necessarily related. Symbols, on the other hand, are never discrete or contingently related. Each symbol is always a universal (verbal or pictorial) and necessarily related to other symbols as a node in a network. Each symbol or concept exists only as "a node in a network of contrasting concepts and its meaning is fixed by its peculiar place within that network" (Churchland, 1984, p. 80). The connections and interrelations among objects are always spatio-temporal and mechanistic.

Table 1. *Complementary relations between art and design*

	Art	**Design**
1	Artist as notator	Designer as tool maker
2	Cognitive	Instrumental
3	Extensions of brain	Extensions of hand, feet etc.
4	Organization of symbol systems	Organization of materials
5	Abstraction of the concrete	Concretization of the abstract
6	Effects changes in states of mind.	Effects changes in states of affairs
7	Intended for communication, expression and metaphorization.	Intended for use
8	Moves from plurality to unity	Moves from unity to plurality
9	Acts directly on mind, and indirectly on reality	Acts directly on reality, and indirectly on mind
10	Inductive, classificatory	Deductive
11	World of symbols: organismic, atemporal, systemic connections	World of objects: mechanistic, spatio-temporal connections.
12	Symbols get their meaning from other symbols (systemic meaning	Objects get their meaning and existence from symbol systems.
13	World of universals, holons.	World of particulars, parts
14	Has reference and self-reference	Has no reference nor self-reference
15	Metaphorical, implicative.	Factual, applicative
16	Idealization, generalization and differentiation	Increasing specialization, specification
17	World of paradigms: totalistic and exclusive. Irreversible paradigms shift	World of styles: coexistence of different styles. Reversible shifts.
18	Incompleteness principle of representation or description.	Completeness, perfect finish.
19	Holistic, analogue and digital	Fragmentalistic, digital systems
20	Open-ended, infinite extensiveness	Closed-ended and finite
	← **Complementary** →	

Table 1. Although the differences between art and design are presented as polar
contrasts, further analysis shows that all the contrasting pairs of attributes are actually complementary pairs. The relationship between the two domains is
therefore more like a yin-yang one rather than a dichotomy.

The interconnections and interrelations among symbols are cognitive and systemic. Symbols have systemic meaning. Objects get their labels, meanings, and some would say, even their very existence, by being subsumed under a symbol (pictorial, verbal, mathematical or other) or a lace of symbols. A symbol denotes or represents a class of entities or objects. Words and pictures have not only reference, but also self-reference. That is, a picture simultaneously denotes the class of objects to which it applies as a pictorial label, and refers to the class of pictorial labels of which it is a member (Goodman, 1968, p. 31). The fact that only words and pictures share this intricate property might allude to some deeper connection between visual and verbal-conceptual thinking. Now, formal systems have reference but can never have self-reference. This is the core of Russell's solution to his famous paradox regarding the self-membership of classes. However, objects have neither reference nor self-reference. An object is always referred to by a symbol, and it is always a specific, singular entity, a member of a class which is named by a symbol.

Conscious thought never takes place except through one or another system of symbols: totemic, pictorial, verbal-conceptual, formal or other system. It never takes place by means of objects, except if certain objects receive symbolic significance as was the case for Neanderthal man (before the invention of painting) and as is the case to this day among primitive tribes. This aspect of objects is found in all cultures, including the most developed. It is a symbolic appendage or vestige carried along by the culture even when it develops much more efficient symbol systems. Today, too, the clothing a person wears, his or her hair style, the kind of car one drives, etc. all have semiotic value.

But unlike verbal or pictorial symbols, objects never form into symbol systems. People have sacrificed their lives for the sake of flags, not because they are beautiful as pieces of cloth, but because of their significance. But all the flags taken together do not create a language or a representation of a language. The parking lot beneath every large office building is a complex social and economic code, but no combination of the hundreds of cars parked there creates a language or a representation of a language. The symbolic value of objects is thus very limited.

In the instrumental realm there are, as we have said, only particulars and therefore all connections and distinctions in this realm are among particulars. In the cognitive realm, by contrast, there are only universals and therefore all the connections and differentiations, analyses, syntheses and transformations, all these cognitive activities, are among universals alone. The system of relations among linguistic or pictorial universals is of a unique sort. One of the most profound differences between the world of design and the world of art is a consequence of this. It is the difference between part and holon.

The word "part" is meaningful only in the instrumental world. In the cognitive, biological, physical or ecological world, by contrast, there are no parts, there are only holons. This term, coined by Arthur Koestler(1967), may well be one of the most important new concepts distinguishing the twentieth century from the world of thought that preceded it. Organismic-systemic

thought of course existed long before Koestler, but the term he coined definitely filled a gap. What Hegel would have given for this concept!

> "But there is no satisfactory word in our vocabulary to refer to these Janus-faced entities: to talk of sub-wholes (or sub-assemblies, sub-structures, sub-skills, sub-systems) is awkward and tedious. It seems preferable to coin a new term to designate these nodes on the hierarchic tree which behave partly as wholes or wholly as parts, according to the way you look at them. The term I would propose is 'holon', from the Greek holos = whole, with the suffix on which, as in proton or neutron, suggests a particle or part" (Koestler, 1967, pp. 65f.).

The term has taken root, especially among system thinkers. In fact it is synonymous with the concept "system", for in the final analysis a system is a set of connected holons. Looked at from "above", a system can be defined simply as a differentiated or stratified holon2. A figurative painting depicting an bull or a horse is a hierarchic system of symbols or a group of connected pictorial holons. In general, one does not take notice of this fact, because there is no need to be aware of it in order to understand the significance of the general symbol as a symbol denoting a bull, in the same way that there is no need to be aware of a language's grammar while speaking or writing it. A simple analysis is sufficient in order to see that the pictorial symbol for "bull" is, in fact, a super symbol that includes subsymbols denoting "head", "body", "legs", etc. Each of these subsymbols includes many other lower level subsymbols. Thus, the symbol for "head" includes subsymbols for eyes, ears, nose, mouth, etc., and each of these subsymbols again includes lower level subsymbols, in line with the level of detail of the pictorial description. The symbol for eye, for instance, may include subsymbols for "eyelids", "eyelashes", "pupil", and so on.

Unlike a figurative painting, a hand axe is neither a mechanical system nor an organismic system. An automobile is a mechanical system but not an organismic system. The differences can be easily understood with the help of a simple example. When a person pricks his finger while pruning a rose bush, all his behavior as an organism is affected. But when one of the wheels of his automobile is parked by chance on a nail and the tyre deflates, no other part of the motor car is affected or 'aware' of it. If a part in a motor car is changed the vehicle's functioning is not necessarily changed or affected. But any change, even the slightest, in a figurative painting is likely to completely alter its meaning. The reason for this is that a figurative painting, a sentence, or any other cognitive structure, is built like nodes in a hierarchic, multidimensional lace. Touch any of them and a quake will pass through the whole lace. Gentle and insightful touch might produce the kind of quake that transforms and reorganises part or even the whole lace. A new enlightenment might then be achieved. On the other hand, a careless touch might be disastrous, or at least create distortions, obscurity and confusion in part or in the whole cognitive lace.

Another deep difference between design and art follows from this structure of interconnectedness. It has to do with the amount of redundancy in the products of each of these domains. In formal and instrumental systems an attempt is made to keep redundancy to a minimum, to avoid it if possible.

Redundancy is one of the negative indicators of these systems. This makes them very economical and very simple, but that is achieved at the cost of making them very fragile. One need remove as little as a single line or period from an equation to ruin it. A failure in one O-ring is enough to have a space shuttle and its passengers blown to smithereens. A crack in your distributor cap smaller than you can see is enough for you to be stuck on the highway. In other words, contrary to the conventional wisdom of common sense, the cognitive world is immeasurably more resistant to damage than the instrumental world3.

The differences described above bring another profound difference between design and art or science into view. In design there are only styles, never paradigms. In art and science, on the other hand, paradigms alone are possible. To appreciate how different style is from paradigm, some of the major characteristics of the paradigm must be specified. This is self-evident for science, where there already have been some major paradigm revolutions. In art, however, it is not at all understood for we are now in effect in the midst of the only great revolution to take place in this realm since its creation by Cro-Magnon hunters some forty thousand years ago. Realism is unquestionably a paradigm, for it represents the only visual Weltanschauung created by man to date. During the last century some two hundred different styles have been proposed for art to replace that single paradigm, but no one succeded to replace it because no style is a paradign.

The deepest difference between a paradigm and a style is that a paradigm tends to be, or at least has the pretension of being, totalistic, even if only for a limited time. Without a paradigm, science or art would simply cease existing, and I claim that until an alternative paradigm to Realism emerges we would do best to adjust to the idea that there is now no art. The totalness of the paradigm is not only in that it provides the theoretical and normative ground of the field but also in that it expresses a world view shared by scientists (or artists) about the significance of the reality they investigate. Therefore, when a paradigm passes away, the reality it described also passes away. Styles, on the other hand, relate only to a skin-deep reality. And a hide (not to mention a garment made of it) can be shed and replaced once a year if not more often.

A paradigm collapses when its generalizing potential is exhausted. It begins to collapse at this stage, and sooner or later a new paradigm arises to replace it, one which is more general and also able to explain what for the previous paradigm had been anomalous findings. Several differences between a paradigm and a style follow from this. Paradigms can be distinguished on the basis of their generalizing power. For style this is meaningless. A paradigm determines what will be considered an anomaly for science. There are no anomalies in style, at most there are deviations from accepted style, about which no one gets particularly worked up because in design departure from the ruling style is itself a norm. The length of a paradigm's existence is not limited by time or season, and its continued existence is conditioned only by its cognitive effectiveness. Styles, by contrast, are definitely time-dependent, and the main impulses for change in style today are primarily economic, social and psychological. Too many people, for example, feel very uncomfortable driving an old motor car even if it runs well and is in good overall condition. A paradigm is like contact lenses that are hard to change, and once changed

can never be worn again. That is to say, a paradigm shift in science or in art is irreversible.

Because of the great difference between the Gestalten of the two paradigms the shift between them cannot be gradual but must take place all at once. Hence every paradigm shift is a revolution. Style, by contrast, is a much milder creature, more tolerant and relaxed. Style can come and go without any hubbub or furore, just like the pretty girls modeling the latest style at a fashion show. Different styles can exist simultaneously in different communities of designers, or even side by side in the same community. What is considered current style in centres of design will become current style in peripheral regions a year or more later. Style has no written or oral theory, and if it is written up, that is years after the style was created. Style is generally distinguishable by several readily identifiable visual features. Compared to the fanatic and totalistic temperament of paradigm, style has much softer norms that are never cognitive or totalistic.

Furthermore, changes of style offer very small surprises, some of which are planned in advance and are introduced primarily by advertising. Paradigms, on the other hand, are always unexpected and when they appear usually cause cognitive earthquakes. Paradigms are not accepted under the impact of high-pressure advertising campaigns but by conviction. A style may be accepted or rejected as a matter of choice and decision. A paradigm, by contrast, is sooner or later accepted because there is no choice! To sum up, we can imagine the differences as follows: In the world of paradigms when a model changes a dress, both the dress and the model disappear at once and forever, and a new model in a new dress appears in their place. The change is so surprising that it takes us time to realize what has happened. In the world of styles, by contrast, the model can change dresses as she pleases and once again exhibit the old styles. Nothing truly dramatic happens. The model and the dress remain with us. To be more precise, something a bit sad happens: none of the dresses disappear and instead they all accumulate in the closet waiting to be shown at any time, but the pretty model grows old and disappears and others come to take her place.

The chaos in art today is only a symptom of the deep crisis affecting any field that has lost its paradigm and has not yet discovered a new one to replace it. The many artists who try to return to Realism delude themselves that that is possible, or that it makes sense to do so. The attempt to return to Realism is like trying to restore life to a fossil flower. In design, you can always go home again, but in science and art you can never go back. Because once you step past the threshold, you and your home are irreversibly transformed. There is something sad about this conclusion, but it is not without hope. I am convinced that art is at the threshold of a new paradigm no less wonderful than the first, but this is not the proper framework for discussion of that.

Another profound difference between design and art, and between the instrumental and cognitive domains in general, is the opposite direction of evolution of each of these vast domains. One developed and develops in the direction of increasing specialization and differentiation, whereas the other developed and develops simultaneously in two opposite directions: towards creating broader and more encompassing generalizations, and towards further and deeper conceptual differentiation. In the one direction, the

discovery of general theory leads to the discovery of even more general theory, and in the other direction an elementary particle does not remain elementary for long. Very quickly a deeper level of reality-mind is probed. The instrumental realm develops like a tree that branches out downwards, and the cognitive realm develops like a tree that grows in both directions simultaneously.

The earliest evidence we have of the making of stone tools are from deposits in Ethiopia from about 2.5 million years ago, and of course we cannot be sure that earlier deposits will not be found. At that stage there began a process of increasing differentiation of tools matched to the various functions for which man needs tools, or specific extensions of his hands. At first this process was extremely slow, but its tempo steadily increased as man's brain grew and as his needs became increasingly differentiated. Thus, for example, Francois Bordes, some of whose findings are reported by Alexander Marshack (1972), found that over 200,000 years ago, the Acheulian hunter used at least twenty-six tool types. The Neanderthal in Europe over forty thousand years ago used at least sixty-three different tool types, and the modern Homo sapiens of the Upper Paleolithic periods used at least ninety-three types of stone tools. These numbers do not include various bone tools nor of course all the tools they employed made of hide, wood, or other perishable materials of which nothing has survived. The number of tools increased to the point that today they number in the hundreds of thousands if not millions. In other words, this process of specialization aspires to create an almost one-to-one match between function and implement. The process of the creation of tools began with many functions carried out by one tool, and we have reached a stage where almost every function and sub-function has a tool of its own. The evolution in the cognitive realm, by contrast, is altogether different.

The earliest cave paintings ever found have been created by Cro-Magnon hunters about 40.000 years ago (Breuil, 1981, pp. 31- 34). However, if the creation of tools required evolution of millions of years, is it likely that the creation of a system of graphic symbols, an immeasurably more abstract creation, required only several thousand years? It seems quit inconceivable that something so complex and abstract simply sprang forth some 40.000 years ago without having roots and origins reaching back much earlier in the deep recesses of human evolution4. But the cognitive evolution leading up to it is not at all clear. To investigate it a new field, which might be called "cognitive archaeology", has to be developed. But let us now return to the basic distinction that concerns us here.

If design represents evolution of an analytic and digital nature, art, as one of the modes of cognitive activity, is both synthetic and analytic in nature. In the view of some researchers, the constant oscillation between analytic and synthetic process is one of the major dynamics of human intelligence5. Any increase in the oscillation to one side is equally important for the other side. Secondly, in a certain sense every word or picture is a unit in and of itself. A verbal or pictorial label that denotes a chair does not also denote donkeys or oranges; it is a universal that denotes only chairs. On the other hand, this label has no meaning apart from its ramified connections with the whole complex of the verbal or pictorial language. That is to say, a word or picture is

a holon or a node in a wholly continuous cognitive web, and as such it belongs to an analogue system.

The analytic tendency in human intelligence tends to create digital systems, whereas the synthetic tendency tends to create analogue systems. Human intelligence is thus not one or the other but the complementary unity of the two6. If design strives for increasing specialization of its products, the cognitive realm strives for increasing generalization and aspires to a relation of one to infinity, like the concept of God in Spinoza; but there is also a branching out in the opposite direction. Even then, however, we remain in the world of universals and do not enter the world of objects.

Another aspect of this is that in the world of pictures, concepts and theories we deal in idealization. A picture depicting a horse utilizes a configuration which is an idealization, scheme or specific pattern for horse. Its form derives from a certain isomorphism with a typical projection or section of the horse. The higher we ascend in the conceptual hierarchy, far into the world of high-level generalizations beyond boundaries a picture can portray, we enter levels where we lose all trace of the distinctiveness of the objects to which the generalization is applied and remain only with structural or formal isomorphism. The higher the generalization the more of reality to which it is applicable, but to the same extent it says less and less about the specific components of that portion of reality. The tendency in the world of design, by contrast, is just the opposite. Instead of idealization we deal, both in the planning and production stages, in specification that is as exacting as possible. That is what is meant by a ' perfect finish'. The object's form is not a consequence of isomorphism with a general pattern but is derived from the specific function the object is supposed to serve.

Finally, there is another aspect to the orientation in design towards specialization and specification. At the beginning of design, the same individual "planned" the tool, visualized it, made it with his own hands, and was usually also the person who used it. Gradually, the role of the designer as toolmaker, which in the beginning was totally holistic, became narrower and narrower, more and more specialized to the extent that many people in industrial design are asking the painful question: " what is left for us to contribute to the making of the object apart from its outward appearance?"

Development in the cognitive world was more complex. In art and philosophy creation from beginning to end is still generally the work of one person. In science there has been a long process of specialization, but in the last decades this direction is being reversed. Sooner or later every specialist digging on his particular spot reaches the point where there is no point or possibility of drilling any deeper, and then the discovery is made that new knowledge is to be found at the crossroads of various fields. At this stage thought begins to move in an interdisciplinary direction. The great intellect of the future will probably be found among generalists not specialists. I suggest that cynics who declare that a generalist is someone who knows nothing about everything consider the apposite definition by Moshe Caspi of the Hebrew University. "A generalist," he says," is an expert in interfaces." The unificatory tendency that has grown and flourished in the world of thought in the last decades is especially apparent in the development of structuralist conceptions in many fields and its parallel in what many regard as a meta-science, namely general systems theory. This no doubt represents a move

towards structural monism. In another work I will show that this is also the direction in which art must move if it is not to be nullified.

Another most important dimension that differentiates between design and art is the amount of open-endedness present in each of these domains. From the very fact that design is focused on instrumental, and hence physical, aspects of our existence, it follows that its products are always finite or closed-ended. By contrast, cognitive products like pictures, words, natural language, or scientific theory have the very opposite properties. They are open-ended. That is, each picture and each word has infinite extensiveness, and this is certainly true of language - verbal or pictorial - as a whole. While design demands finiteness and that the product be perfectly finished, in the cognitive realm only an entity which is dead, only a discarded, fossilized entity can be finite and complete. Indeed, the word "complete" is meaningful only in the instrumental realm. A glass, for example, can be filled with water up to a certain point and then it is absolutely full. Any addition above that point will spill over and will not fill the glass any further. In the cognitive realm, by contrast, completeness has no real meaning except in converse form, as the incompleteness principle of representation or description. That principle stipulates that nothing can ever be described finally and exhaustively.

Description is an infinite process. No word and no combination of any quantity of words, pictures, or formulas wholly describes anything. Rather, at each stage we are forced to accept partial description, in the clear knowledge that the description or information we have is only partial and temporary, and in the knowledge that the work of improving the description or information will never be completed. When a cognitive domain loses this property it is perforce dead. This is precisely what happened to Realism, for example, towards the end of the last century. Impressionism grasped this and tried to save Realism by means of a powerful explosion. But that was Realism's swan song. Like the last and most intense light emitted by a star just before it dies, a supernova. The "art" called Abstract is nothing but the debris of that explosion. Ashes to ashes then!

Cognitive creatures, like living creatures, are not finished at the end. They die. Were that not so, biological or cognitive evolution would not be possible. The great Oxford English Dictionary is in part a cemetery for deceased cognitive creatures. These are creatures which have lost all their power of generalization. They have no more potential for metaphorizing or for extensivity, and metaphorizing is the expression of the open- endedness of cognitive reality. The first rule in this universe is "grow or die"! I hope that in light of the many and deep differences between design and art this analysis has exposed, no grounds remain for claiming that design is art.

3. The Reconciliation

At the beginning of the previous section I stated that I wanted to present the differences between design and art as polar differences. My purpose was to bring out in sharpest relief how different these two realms are, and to eliminate the confusion between them, even if somewhat violently. But now it is time to relax the tension, fine tune the lenses of our analytic microscope,

and bring into view the features shared by design and art, features which until now have been intentionally kept from sight.

The chairs of a century ago were no less handsome and functional than most of those manufactured today. Nevertheless, chairs are being redesigned all the time. This fact has at least two facets. Cynics will claim that the only reason for the constant redesign of chairs is the attempt to promote sales. Even if sales promotion is the primary motive of the manufacturer employing the designer, the latter has a deeper motive which I believe is the very same as that motivating the artist, philosopher, poet, and scientist. This motive is the open-endedness we have spoken of, and which is an inherent property of human intelligence. This intelligence is never satisfied with any given reality in any realm.

However satisfactory the existing reality might be, there will always remain an insatiable hunger and curiosity to investigate beyond what has already been achieved with great effort, to go beyond set boundaries, past the given order and current understanding. The basic attitude of the designer towards his or her creation does not differ substantially from that of artists or scientists towards theirs. They are all motivated by the same marvelous property, the open-endedness of intelligence. Nature did not create different intelligences for man, but people apply the same intelligence to different realms and things. The difference between the designer and the artist, scientist, or philosopher stems mainly from the different properties of their products. The product of the designer is closed-ended compared to that of the artist, which is open-ended, but the motive for innovation and creation in both instances is identical.

In the previous section I presented the main difference between design and art as the difference between going up as opposed to down the cognitive ladder. While this polar contrast accentuates the great difference between the two realms, it can also be misleading. All of us are still in the grips of the law of contradiction, which says that A and not-A cannot both be at the same time. This is part of the legacy we inherited from Greek philosophy and which can become most burdensome if we do not know how to qualify its use. At about the same time that the Greeks devised the law of contradiction, the fathers of Daoism in China formulated the very opposite of this law, the law of complementarity: A if and only if not-A! This is not a very Chinese way to formulate this principle, but it brings out to a Westerner the differences of approach. The yin has no meaning without the yang, and vice versa. Furthermore, yin includes yang within it, and vice versa. As we shall presently see, this has a very profound implication for our subject.

The polarities I presented of instrumentality and cognitivity, universals and particulars, analytic processes and synthetic processes, deductive and inductive tendencies, extensions of hand and extensions of brain, etc. are all rather meaningless when presented as pairs of ostensibly independent alternatives. The truth is much more complex. One has no meaning without the other. That is, they are all complementary pairs, and furthermore, all of these pairs taken together describe one highly complex complementarity. They are merely two ends of the same thing, two tendencies of the same unity. There is no unity without multiplicity and no multiplicity without an awareness of unity. Design and art denote opposite directions on the cognitive ladder, but the essence of wisdom is the understanding that the way up this ladder and the way down are two directions of movement on the same ladder.

They are two central and essential tendencies of mind itself. Humannness resides in neither one nor the other but in their complementarity. The reader may wonder what all this has to do with design. I will presently show that complementarity is the very heart of the internal dynamics of design as well.

In the previous section I argued that design is an instrumental field whereas art is cognitive, and provided a long list of contrasts that followed as a result. The distinction may be significant but it is misleading for it tells only half the truth. The reader may have already asked him or herself whether an implement or object can really be made without the designer first having had an image, concept, or plan as to how the implement or object he or she wants to build ought to look? Is it possible even to imagine an architect coming to a building site without any notion of what he or she wants to build, and on the spot, like an oracle, or an abstract expressionist painter, lets sounds fall from his or her mouth and the unfortunate construction workers start building? Designers will naturally regard this as foolishness not worth wasting thought on.

In the cognitive realm there is no categorical split between the thinking stage and the conversion of ideas into a system of written or pictorial symbols. The two stages are of the same sort. Both are connected to symbol systems, which in one stage are somehow encoded in the brain and in the other have a graphic or acoustic manifestation. In the realm of design, by contrast, the stage of planning and inventing may take place entirely on the plane of symbol systems, but the actualization of the work involves a dramatic and amazing transformation from the cognitive world to the material world, from the world of symbols to the world of objects, from the world of universals to the world of particulars.

Furthermore, to see the object as a chair, house, axe or pot, a transformation in the opposite direction has to be effected; that is to say, universal, conceptual, theoretical lenses have to be put back on. Without those lenses a person in our times, who is a product of a markedly verbal culture, will again see like man did before he had language: he or she will see different things, and perhaps many fewer things, than a person with language sees. To be more precise, at no stage does our designer remove his or her conceptual lenses, but instead ascends and descends the ladder of the hierarchy of universals, the lowest levels of which we call "objects".

The work of the designer thus involves constant oscillation between the two ends of the cognitive ladder which, because of the vast difference between them, look to us like two different worlds. By contrast, the work of the artist, scientist, philosopher, and their like takes place at relatively close levels in the same world. That is to say, design has two sorts of confusions. One is the confusion between design and art, which I hope can be cleared away by means of rigourous analysis of the relations between design and art, which is the object of this essay. The other sort of confusion affecting design is built-in, and is a consequence of its constant fluctuation between the conceptual plane and the instrumental plane. This type of confusion is welcome, healthy and vital for the functioning of design. It is the source of the open-endedness of design as a realm, even though each individual product of design is itself dead-ended. It is the source of the creative tension of design.

It is thus clear that nothing can be made, no tool, garment, building, or spaceship, without some concept, or some conceptual or theoretical system

which at the beginning explicitly or implicitly defines the order, or system of relations, to be actualized in the object. Moreover, a designer or engineer who creates an entirely new kind of instrument must first conceive of a new conception. As a result of this, he adds a new node to our cognitive lace, even before he enriches our instrumental world. In this, design resembles science where, too, observation is not possible without an hypothesis, theory or at the least an expectation that guides the scientist concerning what to look at and for. Popper made this very clear:

> "The belief that science proceeds from observation to theory is still so widely and so firmly held that my denial of it is often met with incredulity... but in fact the belief that we can start with pure observations alone, without anything in the nature of a theory, is absurd... Observation is always selective. It needs a chosen object, a definite task, an interest, a point of view, a problem. And its description presupposes a descriptive language." (Popper, 1969, p. 46).

An image, concept, or plan of a tool is a necessary precondition for designing it, no less than a hypothesis or theory is needed by the scientist to carry out observations. In a delightful exercise that brought this out, Popper told a class of physics students: "Take pencil and paper; carefully observe and write down what you have observed!" They, of course, asked him what it was he wanted them to observe. The lesson for design is clear: the concept of the tool on the cognitive level and the tool that was made on the instrumental level are complementary constituents of a single unity. Furthermore, a very important conclusion follows from this, which the institutions training the designers of the future fail to take with sufficient seriousness, namely the primacy of the cognitive level as compared to the application level. It is obvious enough that there can be an image, concept, or plan of a particular tool without the tool existing in reality, but it is impossible that such a tool will exist without it having been preceded by an image, concept or plan according to which it was made. In other words, activity on the cognitive level is a necessary prerequisite for activity on the instrumental level, but not the reverse.

The supremacy of the cognitive over the instrumental level in the context of scientific, technological, and design activity today is clear enough, but what was the situation more than two and a half million years ago when language and drawing paper did not yet exist? How did Homo habilis make tools without language? This question resembles the classic question: what came first, the chicken or the egg? And again Popper provides us with a deep insight as to the direction in which we need to look to find the answer:

> "The problem 'Which comes first, the hypothesis (H) or the observation (O),' is soluble; as is the problem, 'Which comes first, the hen (H) or the egg (O)'. The reply to the latter is, 'An earlier kind of egg'; to the former, 'An earlier kind of hypothesis'. It is quite true that any particular hypothesis we choose will have been preceded by observations - the observations, for example, which it is designed to explain. But these observations, in their turn, presupposed the adoption of a frame of

> reference: a frame of expectations: a frame of theories" (Popper, 1969, p. 47).

By a similar regression it is easy to understand that every axe was preceded by a concept of an axe, and every such concept was preceded by a different concept of an axe, and so on until we come to the stage where the existence of any linguistic formulation or description of an axe is inconceivable. What then preceded the axe? The answer is simple: an earlier kind of egg! An earlier kind of language; not a verbal-conceptual language but a visual-imagistic language.

Homo habilis made the first tools, as we have said, more than two and a half million years ago, and we can assume that he did not have verbal language. The earliest skull discovered so far, which is also in good condition, is from about that time and is known by its index number at the National Museum of Kenya, 1470. The volume of the brain that resided within that skull was about 800 cc. From a latex cast of the inside space of the skull it was found that this brain had the brain tissue responsible for the production of speech -- the Broca area. But that is not proof that it had language. At the stage in the development of the Broca area reached in this brain, it is apparently responsible for vocalization but not yet for speech (Leakey and Lewin, 1979, p. 205). Homo habilis, and many other hominids after him, did not have verbal speech, but he certainly had the ability to visualize and imagine the tools he designed, otherwise he would not have been able to make tools at all.

Chimpanzee makes a tool for catching ants from a twig from which he removes the leaves and which he inserts into an anthill. He does this without having language but obviously he must have a visual image of the tool he makes as well as an image of the chain of events that will take place after he inserts the stick into the anthill. In other words, visual thought was highly developed millions of years before verbal-conceptual thought began! he making of tools was undoubtedly the most important booster for cognitive evolution, for the improvement of any tool involved a considerable creative and mental effort on the part of the toolmaker, who had first to create a new image or new pictorial universal. That is, at this primeval stage there was no place yet for the fine distinction between hand tools and mind tools. The distance between a particular object and its image was much smaller than that between a verbal or mathematical symbol and the object signified by it. If Piaget's great principle is accepted, namely that concepts and structures are the product of the accommodation and generalization of experience, it is clear why the making and use of tools shaped our thinking at the most basic level (Piaget, 1971, p. 63). There appears to be a spiral connection between the making and use of tools and cognitive evolution. As the tools improved so did categories of thought, and as the latter improved further improvement in the tools became possible, and so on. Instead of one kind of stone tool, as at the beginning of toolmaking, a group of tools gradually came into being in which the quantity of tool types steadily increased. But different types of tools represent different instrumental functions and therefore also represent increasingly fine image-conceptual differentiation.

Imagine a galaxy with two vast arms; the galaxy revolves, rises and spreads out in boundless cognitive space. This galaxy appears to have one instrumental arm and one cognitive arm, but they are really one arm with two ends extending in opposite directions from one mind. The cognitive products of this spiral evolution were at first natural language and later, forty thousand years ago, the invention of figurative painting. That was perhaps the summit of visual thought, and it was also the first extension of brain. With that, I believe, the chapter in cognitive evolution in which the use and manufacture of tools had a developmental and formative influence came to an end. Henceforth this evolution was influenced and advanced by symbol systems developed by man, such as totemistic, mythological, religious, pictorial, philosophical, formal and scientific systems. In my view the invention of painting had a critical role in this evolution, because it was the beginning of writing without which conceptual hierarchies in any cognitive realm cannot be constructed. Mankind needed tens of thousands of years to exhaust the thinking potential latent in the cave paintings. The Gutenberg revolution completed the exhaustion of the communicative potential of painting, and Realism, which ran its course at the beginning of this century, exhausted its artistic potential. This is a multi-dimensional phenomenon: it has a creative, expressive, communicative, and other dimensions.

If earlier, in the second section of this essay, the differences between design and art were exaggerated, we may have gone too far in the opposite direction here. We should therefore zero in once again and stress that the problem posed at the beginning of this examination is genuine. Despite the factors and dynamics design and art share, neither of these realms can be reduced to the other. Even though at a deep level of human intelligence they are connected, on another level they are characterized by profound differences, the most important of which is that the designer starts from a universal and descends to an object. The artist, by contrast (and also the scientist, philosopher, and poet), start from a universal but aspire to rise to a higher universal. That is the basic difference between design and art, and it cannot be eliminated without obscuring the demarcation lines between these two vast domains.

When we understand how large a role the design of tools played in human evolution and realize that nothing designers make today will have any influence on future cognitive evolution, it is hard not to feel sad. However, one should bear in mind that design's functions today are not those it had in primeval times. Cognitive evolution has long since passed the stage in which the invention of a tool or a new symbol system is likely to have significant influence on cognitive development. When a wider view is taken, it is seen that the arrowhead of toolmaking today is located not in departments of design but in departments of computer science and engineering. There, right before our eyes, the second extension of brain in human history is being constructed.

Painting, and in its wake, writing, were means for preserving information, an extra-skull unit of memory. Now not only is an unlimited expansion of human memory and of the quantity of the connecting circuits of the human brain being built, data and information processing extensions are also being created, and in the future much more can be expected. The synthesis and complementarity of the instrumental and the cognitive reach new perfection in

the computer. This complementarity was implicit in the prehistoric stone hand tool, but in the computer it is wholly explicit. This tool is sure to have decisive influence of man's cognitive evolution, but it is unlikely that anyone today can imagine what the nature of that influence will be. Above all, it must be borne in mind that there is a broad evolutionary continuity here: from stone tools to painting, and from painting to "artificial" intelligence, but the first and main activator of this for millions of years was toolmaking and tool use.

Throughout this essay I have used the double analogy between art and science on the one hand and design and technology on the other. Here I should add the reservation that the relationship between art and design is fundamentally different from the relationship between science and technology in at least one important respect: science may contribute to new developments in technology, and technology may contribute to new developements in science. There is, however, no spiral connection or mutuality, certainly not today, in the relationship between art and design. But as I have already remarked, some spiral connection must have existed in the distant past between the evolution of tool making and the evolution of visual thinking. It is almost certain that this connection was a central factor in the invention of art.

NOTES

1. It is not my intention to evade discussion of this fundamental question. On the contrary. The present essay is part of a much larger work which tries to answer a number of fundamental questions such as: What is art? How was it created? Why did it die in the twentieth century? What are the chances that it will be rebuilt in the future? And if so, what kind of art will it be? For a fascinating discussion of the problem of demarcation in science, see Karl R. Popper (1968).
2. A highly sophisticated exposition of holonomic thinking is presented by Jeffrey S. Stamps (1980). See also the now classic book by Bertalanffy (1968).
3. For a clear explanation of basic concepts in information theory and their application in art, see Moles (1968).
4. In another work I intend to show that the roots of the "sudden" invention of art go back at least several million years.
5. See, for example, Viaud, 1960.
6. The discussion of the dynamics of digital and analogue systems is very complex and I shall not pursue it any further here. A clear discussion of the subject is found in Bateson (1979).

REFERENCES

Bateson, G., Mind and Nature (New York: Bantam New Age Books, 1979).
Breuil, H., "The Paleolithic Age," in Larousse Encyclopedia of Prehistoric and Ancient Art (London: Hamlyn, 1981).
Churchland, P. M., Matter and Consciousness (Cambridge, Mass.: The M.I.T. Press, 1984).

Gelb, I. J., A Study of Writing (Chicago: The University of Chicago Press, 1963).
Goodall, J. Van Lawick, In the Shadow of Man (London: Collins, 1971).
Goodman, N., Languages of Art (New York: The Bobbs-Merill Company, Inc. 1968).
Kuhn, T. S., The Structure of Scientific Revolutions (Chicago: The University of Chicago Press, 1970).
Koestler, A. The Ghost in the Machine (London: Pan Books, Ltd., 1967).
Leakey, R. E. and Lewin, R., Origins (London: MacDonald and Jane's Publishers, Ltd, 1979).
Marshack, A., The Roots of Civilization (New York: McGraw-Hill Book Company, 1972).
Moles, A., Information Theory and Aesthetic Perception (Urbana, Chicago, London: University of Illinois Press, 1968).
Piaget, J., Structuralism (London: Routledge & Kegan Paul, 1971).
Popper, K. R., The Logic of Discovery (London: Hutchinson, 1968).
Popper, K. R., Conjectures and Refutations London: Routledge & Kegan Paul, 1969).
Stamps, J. S., Holonomy - A Human System Theory (Seaside, Calif.: Intersystems
Publications, 1980).
Viaud, G., Intelligence - Its Evolution and Forms (London: Arrow Science Series, 1960).