

Pavel B. Ivanov

NONLINEAR ART

Abstract

Art is treated as a nonlinear phenomenon, and three levels of nonlinearity are discussed. The balance of imaging the world and self-expression depends on the level of nonlinearity chosen: on the level of external nonlinearity, the arts produce frames for experiencing the world; on the level of internal nonlinearity, formal transformations of the world are tried; on the level of hierarchical nonlinearity, the practical attitude to both abstract reflection and abstract creation serves to produce a genuine work of art allowing many-level perception.

Traditionally, there are two opposite attitudes to artistic creativity: the “realistic” doctrine insists that every work of art be a reflection of some reality, while the advocates of “pure art” proclaim independence of any reality as the fundamental principle of art. The exaggeration of the imaging side of art leads to naturalism and hypernaturalism and even to denial of the necessity of any art at all. On the other pole, one finds all kinds of “spontaneous” art, combining sounds, paints or other forms in a random manner. As usual, the polarities meet, and the collections of arbitrarily chosen objects exhibited as examples of free self-expression in “conceptual” art little differ from the well-known Duchamp’s ready-mades. Still, there are strong claims from the both camps, and much argument about “authentic” art, with one or another school put forth as its representative. To uncover the truth, one has to consider the differences between various trends in the arts from an integrating standpoint to allow comparison and discrimination among the existing possibilities using definite criteria.

The natural way to come to such a universal view would start from the general schemes of human interaction with nature, conscious activity [1, 2]. Any activity assumes a repeated sequence of assimilation of an *object* by a human actor (*the subject*) followed by generating another object intended for being assimilated in a particular way (*the product*):

$$\dots \rightarrow Ob \rightarrow Sb \rightarrow Pd = Ob' \rightarrow Sb' \rightarrow Pd' \rightarrow \dots$$

In the process of interiorization, the product becomes an internal state of the subject rather than a commonly observable thing; in a well-developed activity, the subject many times acts upon itself before it comes to an outer action, and hence any product must bear the signs of that reflexivity. In natural sciences, numerous similar phenomena are known as manifestations of *nonlinearity*. Since the determinative characteristic of the subject is universality [3, p. 38], one can conclude that the subject’s nonlinearity is also a universal feature of every activity; universality distinguishes it from nonlinearity in inanimate or living systems. However, the general properties of nonlinear systems known from natural sciences will be present in conscious systems as well, and any kind of activity at all might be studied from the viewpoint of nonlinear effects involved.

The essentially nonlinear character of art has been earlier considered in the context of information processing [4]. It has been indicated that creative communication provides a mechanism of generating new information on the basis of a message that did not contain it before, but rather synchronized the intended receiver’s inner processes with external activities, in a specific way (“information laser”); this example also illustrates such an important feature of nonlinear systems as the ability to support various collective modes of motion that can behave as apparently stable particles moving in a quasi-linear medium. There are indications that consciousness as such is one of such collective effects in a social system.

It should also be noted that aesthetic perception could be described in informational terms, which is equivalent to introducing a nonlinear operator of discordance, with its average values measuring the subjective incompatibility of elementary tones [5].

There are different ways to approach a mathematical representation of nonlinearity. This work is mainly focused on the dynamic aspect, that is, the relation to the equations of motion governing the system's behavior. I do not consider the chaotic modes of motion and statistical structure formation (fractals). From the dynamic viewpoint, three levels of nonlinearity can generally be distinguished; here, they will be referred to as "external", "internal" and "hierarchical" nonlinearity.

On the first level, nonlinear behavior arises from a limited way of observing a linear system, which is formally described by various types of *clipping* the full phase space in the process of observation. The observer does not influence the system to observe, but the continuity of its phase trajectories gets lost in perception; that kind of behavior could be related to properties of the simplest nonlinear function commonly known as unit-step, or Heaviside function:

$$\theta(x) = 0 \text{ for } x < 0 \text{ and } \theta(x) = 1 \text{ for } x > 0$$

In physics, similar discontinuities appear as boundary conditions of the wall (mirror) type; in some systems, they can lead to chaotic behavior; in other cases, there are continuous solutions (standing waves) with nodes on the boundary. One will immediately obtain external nonlinearity, when an infinite phase space is being projected onto a finite (at least in one dimension) subspace. For a simple example, consider a rectangular window opening to the system of interest: depending on the position and orientation of the window, one will observe different patterns of motion. Of course, there are many other possibilities; for instance, one might register only the points of intersection of a continuous (phase) trajectory with a fixed surface, which, in some cases, may impose a "discrete" character to the observed picture of motion, up to complex quasi-stochastic patterns.

The reflexivity of activity associated with that level of nonlinearity can be related to the choice of the size and shape of the aperture clipping the field of view. This is a peculiar kind of product that is always accessible to humans as a powerful means of manifesting their universality. Any natural thing at all can be included in the sphere of human activity through merely establishing its relation to some accessible product. Thus, we cannot physically influence a distant star from the Earth; still, the star can be made a part of our culture as an object distinguishable from the others, and hence culturally connectable to all kinds of real or imaginary objects (such as the visually adjacent stars in a constellation, or the eyes of the beloved). When put into an aesthetically saturated environment, anything at all can acquire an aesthetic quality and become a work of art, regardless of whether it has intentionally been produced as art.

This latter point is very important in assessing many phenomena in modern art using the common articles that originally had no relation to the arts. The Duchamp's urinal might well appear as a piece of art provided it were *regarded as such*. This not the quality of the thing itself that makes it an artwork, but rather the way of its observation and perception presenting it in its universality, as a part of the culture. This is a fundamental feature of any product at all, but it is primarily in the arts that it becomes essential and determinative. In the context of the art, things are never the same as they might be in any other field of activity, or in nature. There is absolutely no need to invent something unusual or unnatural, to make art. Thus, a random photograph can beat any masterpiece, while a pretentious abstract painting could remain sheer waste of paint. On the other hand, no art, however naturalistic, can reproduce nature exactly as it is, just because it is bound to reproduce it in a different material; mere projection of a three-dimensional thing onto a plane is enough to make it somewhat quite special, to be judged by appropriate criteria.

This is where universal reflexivity enters the game. Any product deserves the name of a work of art if and only if it can be treated as an instance of the humanity's self-reflection, representing a scheme of activity in another activity. It does not matter which particular kinds of material have been used, and the degree of their transformation does not play a significant role. What only matters is the way we look at the world.

This disclosure of the peculiar faces of reality could be regarded as a definition of art. Other levels of creative spirituality (such as science and philosophy) will imply this capacity as a necessary premise; that is why their inner development will always show certain artistic traits.

The next (internal) level of nonlinearity is characterized by the presence of nonlinear terms in the equations of motion [6]. The model of a driven and damped anharmonic oscillator can illustrate the typical possibilities:

$$\ddot{x} + a(t)\dot{x} + b(t)x + c(t)x^3 = f(t)$$

The presence of the nonlinear term proportional to the third power of x makes the dynamics of such a system most complex and sensitive to initial conditions as well as the variation of the coefficients a , b , and c . This *explicit* nonlinearity has been widely discussed in the literature. However, in this model, nonlinearity can also be introduced in an implicit way. Thus, one could assume that the force $f(t)$ is not analytical in t , in particular, exhibiting jumps or other singularities. In this case, the behavior of the system near a singular point of the force may differ from one region of the phase space to another, which is equivalent to an effective nonlinear dependence on x and \dot{x} , which is present even in the absence of the cubic nonlinear terms, that is, with $c = 0$. Such systems can manifest a complex self-correlated behavior, like in the school example of the parametric resonance. Yet another type of implicit nonlinearity is associated with the non-analyticity of the coefficients $a(t)$ and $b(t)$; it is only recently that such nonlinear systems have attracted a significant attention, mainly in the field of stochastic dynamics [6].

Systems with explicit nonlinearity are a classical model of self-action; in particular, they can be immediately related to essentially reflexive human activity, including the arts. Implicit nonlinearity might correspond to the various kinds of cultural influences on individual activity.

Applied to the arts, the concept of internal nonlinearity refers to the transformation of reality in the very process of its incorporating in a work of art. Communication between the members of society serves as the fundamental mechanism of this transformation: when we speak of the folding of inter-person communication into self-communication, this is an instance of explicit nonlinearity; when it comes to communication between the different levels of the subject (*e.g.* an individual and a group) implicit nonlinearity is to be considered.

In fact, this level of nonlinearity is necessarily present in every work of art, since the very notions of subjectivity and creativity imply a repeated interaction of the creators with themselves, and hence explicit nonlinearity. No figurative art can develop without transforming reality in certain aspects, as artistic naturalism is nothing but *imitation* of nature, rather than its reproduction. Few people would insist that the aesthetic value of artwork could be measured solely by the accurateness of imitation. There is much more controversy about the social position of art, related to implicit nonlinearity. Paradoxically, denial of any sociality in the arts is typical for the creative schools entirely based on explicit nonlinearity (impressionism, abstractionism, etc.); here, they do not differ from the advocates of “pure art” from the “realistic” camp. However indirect, the cultural dependence of art can never be discarded; in most arts, implicit nonlinearity is of the primary importance. Once again, the assessment of a product as a work of art cannot entirely be based on formal criteria; it demands universal reflexivity. Obviously, this is equivalent to the demand that every work of art reflect the major trends in the contemporary cultural development.

The difference of external and internal nonlinearity is reflected in the millennia-old argument about the primacy of imaging or imagination in the arts. A prevalence of external nonlinearity leads to the conception of art picturing the world as close to reality as possible; conversely, the exaggeration of internal nonlinearity is evident in aesthetic theories putting forth free self-expression as the final goal of art. However, any picture of reality is already an instance of transformation, and no transformation is possible without something to transform. Internal and external nonlinearity will always coexist in the arts, and it is their mutual saturation that results in the uniqueness of an individual artwork; this brings us to considering the synthetic level of hierarchical nonlinearity.

This kind of self-action is related to the development of a nonlinear system through interaction with its environment. The stages of the system’s development become the levels of its hierarchy; the reflection of one level in another produces a special kind of nonlinearity, combining the features of external and internal nonlinearity.

Development is difficult for the formal study to grasp. Hierarchical nonlinearity is usually formalized in a static way, following one of the possible ways of unfolding the system's hierarchy. Statistical description could serve as a typical example: the complete description of the system's dynamics is being replaced with a few average characteristics, so that their evolution could be treated as a higher-level process, with its own regularities. In certain cases, this higher-level dynamics may be governed by simple laws resembling those found at a lower level (adiabatic processes); in other cases, kinetic description may be possible, with the evolution of the macroscopic state of the system governed by "master equations", usually obtained through averaging the lower-level equations of motion (like in physical kinetics) or utilizing the presence of some natural structures on the lower level (*e.g.* in chemical reactions).

For the higher level, the representation of the entire phase space with a few average quantities resembles the clipping of the phase space on the level of external nonlinearity; the very idea of a statistical distribution implies segmentation of the phase space into a number of unit cells [7]. For the lower level, the influence of higher-level constraints is analogous to implicit nonlinearity introduced through the dependence of the equations of motion on external parameters.

Other models of hierarchical nonlinearity are possible as well. For instance, employing the approach of Hamiltonian dynamics, one might consider canonical transformations, with a few coordinates replaced by the quantities related to the system's integrals of motion; the approximate invariance of such new coordinates would then suggest their treatment as higher-level parameters as compared to the evolution of the other (rapidly varying) quantities. The well-known example of the reduction of the motion of a number of material points to the motion of their center of mass could be mentioned in this relation. In general, splitting the whole system into relatively isolated subsystems is a nontrivial problem, which may be especially difficult when the system's evolution may involve structural changes, or phase transitions.

The idea of multilevel perception of art has long since become a banality. However, very few theories of aesthetic perception and creativity account for their hierarchical nature. One of such models employs an informational measure of discordance and quantum mechanical considerations to construct a hierarchy of musical scales and predict their properties and evolution [8, 5]. Still, a number of qualitative conclusions could be drawn without much recourse to mathematics. First of all, the unity of external and internal nonlinearity implies communicating schemes of activity along with its products, which makes any communication act hierarchical, with at least two levels. That is, a work of art must intentionally control the observer's attention, and not merely suggest a picture to look at. This can only be achieved through socially organizing the process of aesthetic perception, so that every aesthetic act would be embedded in a certain cultural context. For instance, the very atmosphere of an exhibition hall assumes quite particular ways of behavior, all deviations being socially discouraged. Art criticism and other social response mechanisms produce the same effect on the creators. For an immediate consequence, some kinds of art may acquire irreproducibility, with every aesthetic act becoming unique because of the impossibility of reproducing the cultural conditions that make it an artistic performance. Thus, a joke cannot be repeated with the same success, and Duchamp's ready-mades would not produce any noticeable impression on a modern connoisseur of art; similarly, most samples of Neanderthal art can only have historical rather than aesthetic value, though some of them could be revived as art through including them in a quite different cultural context, thus adding external nonlinearity. That is, one has to account for cultural realities to be able to produce art, albeit not entirely acceptable for the contemporaries.

To summarize, an artist is free to produce forms as well as fill them with a culturally significant content, which will ensure the universality of the product and its hierarchical perception. The proportion of external and internal nonlinearity may vary depending on the aesthetic task; still, the author must recur to the both, seeking for a peculiar balance, without which no creation would deserve the name of art.

References

1. A N Leontiev *Activity, Consciousness and Personality* (Englewood Cliffs, NJ: Prentice Hall, 1978)
2. P B Ivanov "A hierarchical theory of aesthetic perception: Scales in the visual arts" *Leonardo Music Journal*, **5**, 49–55 (1995)
3. E V Ilienkov *Dialectical Logic* (Moscow: Politizdat, 1984)
4. P B Ivanov "Art as creative communication" *Interaction between Man and Culture: Information Standpoint* Proceedings of International Symposium (Taganrog, Russia, 1998) pp. 95–100
5. P B Ivanov "Discreteness, continuity and hierarchical scaling in the arts" *Information Approach in Empirical Aesthetics* Proceedings of International Symposium (Taganrog, Russia, 1998) pp. 66–77
6. H M Hubey *Diagonal Infinity* (N.Y.: World Scientific, 1999)
7. L D Landau and E M Lifshitz *Statistical Physics*, part 1 (Moscow: Nauka, 1976)
8. L V Avdeev and P B Ivanov "A mathematical model of scale perception" *J. Moscow Phys. Soc.*, **3**, 331–353 (1993)

<http://unism.pjwb.net/arc>

<http://unism.pjwb.org/arc>

<http://unism.narod.ru/arc>