

Massimo Negrotti

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SAPERE

The Reality of the Artificial

Nature, Technology and Naturoids



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*“Ad Alessandro e Angelo Maria e ai loro
sguardi sorridenti”*

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Part I

Chapter 1

Daedalus and Icarus

History and mythology agree to assign to the human ambition to build objects inspired by nature a very ancient origin. It is certain that the ambition to reproduce and improve natural objects and events constitutes for humans a sort of constant goal, almost an imperative whose achievement seems to be linked not only to practical utility, but also to people's deepest psychology. Furthermore, when the reproduction takes the form of artistic, literary, or musical representation, the representational bias clearly shows how the externalization of one's visions of the world is definitely a universal need for human beings.

Nevertheless, the reproduction of something natural is never an easy enterprise, and, as we shall see analytically in this work, the actual replication of a natural object or process by means of some technology is quite impossible. Therefore, it seems to be reasonable to introduce the term *naturoid*¹ to designate any real artifact coming from the attempt to reproduce natural instances.

One of the most ancient naturoids, though only imagined, is surely that of the artificial wings designed for Icarus by his father, Daedalus, who, according to classic mythology, came crashing down near Samo, because the wax that fixed his wings had melted. Icarus probably repented bitterly for not having followed the advice of Daedalus, who had warned him not to get too close to the Sun. While a bird, in a similar circumstance, might only have been singed and would soon have descended to more reasonable heights, the artificial wings of Icarus could not withstand the test, and he died suddenly.

On the other hand, we know that Homer, in the *Iliad*, describes the god, Efesto, who creates the first woman, Pandora, from clay; Plato speaks of the mobile statue built by Daedalus himself; Argonauts, who searched for the Golden Fleece, had an artificial watchdog at their disposal.

¹ The author introduced the term 'naturoid' in the book 'Naturoids: On the Nature of the Artificial,' published in 2002 by World Scientific Publishing. Some material from that book is reproduced here with kind permission.

Attempts to reproduce natural instances date back to antiquity. As has been noted (Boas 1927; Vogel 2000), such attempts are even found in the early forms of art and in several fantastic poetic or religious accounts. As stated by de Solla Price,

Our story, then, begins with the deep-rooted urge of man to simulate the world about him through the graphic and plastic arts. The almost magical, naturalistic rock paintings of prehistoric caves, the ancient grotesque figurines and other ‘idols’ found in burials, testify to the ancient origin of this urge in primitive religion (de Solla Price 1964)

Furthermore, automata—reproductions of human beings very different from one another in terms of their substance—have abounded throughout the history of human imagination, starting with the Bible and including Faust and the *Rossum’s Universal Robot* (R.U.R.) by Čapek.

It would surely be very easy to expose, case by case, the weak points of each of the ‘machines’ quoted above, but there is another much more compelling question. What kind of relationship exists between these attempts to imitate nature and the technology of that particular historical period? In other words, is technology intrinsically intended to reproduce something existing in nature, or is it developed with other aims in mind as well? After all, it is like when we ask ourselves: has man created technology only to reproduce nature?

The history of technology clearly shows that man, in designing and building objects, machines, and processes is often motivated by a desire to imitate, but in many other cases he aims to control and dominate natural events, rather than reproduce them by means of expedients which are refined to varying degrees. As the mathematician Henry de Monantheuil stated in the sixteenth century,

... man, being God’s image, was invited to imitate him as a mechanician and to produce objects which could cope with those made by Nature (de Monantheuil 1517, in Bredekamp 1993)

In order to control natural events one needs to know them and our technologies will vary in their effectiveness according to the accuracy of this knowledge. However, these technologies will not necessarily be designed to imitate the phenomena in question, but to adapt to nature in order to exploit its features and reach some useful goal.

Thus, knowledge of some physical laws allowed us to build machines, such as electrical or internal combustion engines, which enhance our ability to move physically. The advent of writing led to the invention of various writing tools which, today, are highly advanced thanks to computer technology. The knowledge and the exploitation of other natural laws made it possible to conceive, and then construct, systems like the cathode-ray tube which make the display of graphs or images, possible.

In all these examples, and in the many more one could easily cite, there is no attempt to imitate, but, rather, an attempt to invent, to make behaviors, effects, and events possible which, on the basis of our pure and simple natural condition, would not be attemptable.

To sum up, close to Icarus—and to all his descendants who constitute the world of the *artificialists*—the figure of Prometheus stands out. In giving fire to man, he awakened man's ability to invent, i.e., his ability to establish construction targets for objects or processes, as it were, additional and therefore different from those already existing in nature.

As we know, in doing so, unfortunately man created dangers and disasters. Prometheus himself was the first to pay, with tremendous torture, for having taken possession of fire, which was a prerogative of the gods. Nevertheless, imitation and invention are two distinct circumstances and actions, and they require analyses which are likewise different.

In the following pages, we shall investigate and outline some fundamental aspects of the first of the above technologies, namely the *technology of naturoids*. A clear distinction is drawn between the technology of naturoids and *conventional technology*. Unlike the latter, the former implicitly or explicitly aims to reproduce something existing in nature. This distinction may be applied to all technological traditions, from the most prescientific to the most advanced ones, including nanotechnology, rightly defined by Crandall and Lewis as

a descriptive term for a particular state of our species' control of materiality (Crandall and Lewis 1997)

Nanotechnology, in fact, can be oriented either to reproduce natural things or processes, exhibiting different features, or to produce new objects or materials. Indeed, nanotechnology may be oriented to design nanomotors or even artificial white cells, or to emulate other biological nanostructures able to perform useful tasks within the human body, though

For the manufacture of more sophisticated materials and devices, including complex objects produced in large quantities, it is unlikely that simple self-assembly processes will yield the desired results. The reason is that the probability of an error occurring at some point in the process will increase with the complexity of the system and the number of parts that must interoperate. (National Materials Advisory Board 2006)

The dichotomy between conventional technology and the technology of naturoids tracks a distinction that, though accepted as a fact on a commonsense basis, has never been clearly drawn, but it is very useful in trying to understand rationally a wide range of phenomena which are not just technological.

In fact, some authors seem to have touched the subject, calling by a special name—namely 'alternate realizations'—the machines designed to replace natural structures (Rosen 1993) or maintaining the opportunity, for the human species, to adopt, in manufacturing, a nature-oriented *mimicry* strategy (Benyus 1997). Even Herbert Simon, in his seminal work "*The Sciences of the Artificial*" (Simon 1969), gives no particular relevance to the term 'artificial,' limiting himself to recognize that, sometimes, artificial things coincide with 'synthesized' objects, i.e., with objects built by drawing inspiration from natural ones.

The need for a new name—namely, naturoids—comes from the fact that, traditionally, all technological devices are defined as artificial, quite neglecting the

important teleological difference sketched above. Even during the long debate on the feasibility of artificial intelligence projects, the problem was in no way placed in a larger frame, that is to say that of the general methodological rules that characterize the human attempt to reproduce natural instances. Such rules have to be understood as a sort of ‘action plane’ that, although not explicit, intrinsically characterizes the ideation, the design and then the realization of any naturoid.

Of course, at some detailed level, such as the nanotechnological or the atomic, one can think that the distinction between natural and artificial things disappears. Actually, the processes that are going on at these levels, be they natural or man-made, tend often to be indistinguishable. Nevertheless, at a more human-scale level, things are different since humans have always tried to imitate, or to concretely reproduce natural objects *as they see them*—both through their eyes and indirectly through some observation tool—and sometimes even as they *imagine*. In this frame, though the distinction between natural and artificial is certainly a heuristic one, as it happens for any scientific criterion, it may be useful for understanding the design of a class of artificial things, namely naturoids, and not of the whole range of man-made artifacts. Probably, like quantum physics is needed to understand what happens in microworlds, whereas classical physics works well in macroworlds, a theory of naturoids could be useful at its proper level, whereas it may be inapplicable at other levels.

We may consider imitation and invention—i.e., the basic human qualities which generate the technology of naturoids and conventional technology—as human aptitudes which, on a social and cultural level, give rise to very different classes of behaviors and activities. Imitation, for instance, exhibits a variety of expressions which range from the socialization of children to fashion, and the spreading of cultural models (scientific, technological, ethical, religious, juridical, etc.).

Imitation may sometimes include a true reproduction activity that concerns, as a target to be imitated, even man-made things or events.

This has happened many times in the field of works of art, and this justifies the use of both the terms ‘imitation’ (when one tries to only mimic some aspects of the appearance of an object or a process) and ‘reproduction’ (when one tries to reproduce something adopting a more or less detailed analytical model of it). As applied to works of art, the term reproduction was discussed, perhaps for the first time, in an influential 1936 article by W. Benjamin, entitled “The Work of Art in the Age of Mechanical Reproduction” (Benjamin 1936). Benjamin’s speaking of *reproduction of a man-made work*, allows us to see that a theory of naturoids may be useful even when the object to be reproduced is not natural. For example, in the field of acoustics, digital surround-sound effects may try to emulate the man-made effects of Gothic churches, just as stereo effects try objectively to reproduce the practice introduced by Giovanni Gabrieli, in the church of San Marco in Venice during the sixteenth century. Digital technology allowed the Japanese company Yamaha in the late 1970s to emulate an acoustic piano, although, for various intrinsic reasons, such a piano cannot be compared to, say, a real Steinway D and its ‘aura,’ to use Benjamin’s word.

To sum up, imitation is a larger area than that of naturoids, because it includes all attempts to remake something already made by man, both for counterfeit aims or for improving an existing device or process. However, in both these cases—which are beyond the scope of this book—we presume that the ‘action plane’ of the designer remains the same.

Invention, on the other hand, manifests itself in innovative social behaviors—which, when they succeed, will be imitated, as the French sociologist Gabriel Tarde explained a century ago (Tarde 1890)—and also in various typologies of economic enterprises, in exploration activities and in the generation of new ideas.

In the technological domain, invention and conventional technology work assuming that humans can imagine and realize objects, processes or machines by adopting natural resources in order to achieve additional aims as compared to the basic natural ones, often conceived even as ways to act against nature (Bensaude-Vincent and Newman 2007). In fact, invention is a kind of activity often based on an abstract rational way of studying and controlling the world by grasping and exploiting its uniformities through means of mathematical models. In this regard, we should not forget that, as Poincaré rightly states,

The genesis of the mathematical creation is ... the activity in which the human mind seems to take very little from the external world, and in which it acts or seems to act only by itself and on itself ... (Poincaré 1952)

and, therefore, conventional technology places itself in a domain where human imagination and natural laws meet, giving birth to devices which are not experienced within nature, though they should match its features.

Conversely, in our approach to the field of artificial things, that is to say to the naturoids domain, we shall concentrate on those particular fields of activities which place at their center, on the basis of a more general imitation ‘instinct,’ the reproduction of something existing in nature, and whose reproduction—through construction strategies which differ from the natural ones—man considers to be useful, appealing or in any case interesting.

While awaiting the new technologies which, according to Drexler’s vision of nanotechnology, will allow us to

build almost anything that the laws of nature allow to exist, (Drexler 1986)

we shall take into consideration the efforts of men who try to reproduce natural instances through ‘macrotechnology’ strategies, on the basis of analytical models they build for such instances.

Chapter 2

Artificiality and Naturoids

The use of the term ‘naturoid’ calls for the resolution of an ambiguity that involves the concept of ‘artificial’ in many contexts. From a linguistic standpoint, the term artificial (*artificiale* in Italian, *künstlich* in German, *artificiel* in French) covers a heterogeneous area which should be clarified before we proceed. In all languages, this concept seems to generically indicate all that is “man-made” or “not natural” and, at the same time, though more rarely, something which tries to imitate things existing in nature. Nevertheless, it is a fact that, while no one would speak of an ‘artificial telephone’, everyone understands the meaning of an ‘artificial flower’ quite well. We believe that this situation can be interpreted quite easily. Though it has never been rationally defined, the concept of artificial, as an adjective, refers to an object, process or machine which aims to reproduce some natural object or process. Since flowers exist in nature but not telephones, the adjective ‘artificial’ has no meaning if we attribute it to any object invented and built by man, i.e., an ‘artifact’, while it takes on full meaning when it is finalized to reproduce a natural object.

The Italian linguists Devoto and Oli have correctly defined the artificial as an object obtained by means of technical expedients or procedures which *imitate* or replace the appearance, the product or the natural phenomenon. Likewise, the imitation component is defined by the same authors as the capacity to get or to pursue, according to some criterion, varying degrees of similarity. The ambiguity of the question emerges, however, from the definition of the adjective ‘feigned’ which, according to Devoto and Oli, defines a product obtained *artificially* as *imitation*.

Undoubtedly men but also many animals, are familiar with the art of imitation and of deception. (But, by the way, who would have accepted, for instance, the expression ‘feigned intelligence’ rather than ‘artificial intelligence’?). Anyway, the semantic weight of this feature on the concept of artificial, definitely seems to be too high.

The *perspectiva artificialis* of Leon Battista Alberti and Piero della Francesca—but also the landscape paintings of the so-called Quadraturism school, born in the sixteenth century and enjoying success in subsequent periods (for instance, with Andrea Pozzo and his vault in Saint Ignazio in Rome), may be defined ‘feigned’, if you will, but only in the sense of something modeled, moulded by man as it is for the Latin origin of the verb *fingere* . However, the proper meaning of the term artificial is something that has often circulated in our culture in the most different fields, for instance in the following statement by Thomas Jefferson

I agree with you that there is a natural aristocracy among men. The grounds of this are virtue and talents there is also an artificial aristocracy, founded on wealth and birth, without either virtue or talents; for with these it would belong to the first class. The natural aristocracy I consider as the most precious gift of nature, for the instruction, the trusts, and government of society. May we not even say, that that form of government is the best, which provides the most effectually for a pure selection of these natural *aristoi* into the offices of government? (Jefferson 1813)

To sum up, though in every naturoid there is a deceptive or ‘illusory’ component by definition, it is not its only component, because its main character is, rather, to reproduce something natural. While we may deceive people through various kinds of technological devices, such as conjurers and illusionists, but even designers and architects do, the deception coming from an artificial device is the most impressive since through it humans savor the power not only to dominate nature, but also to rebuild it at will. Thus, as described by Pliny the Elder, in the competition between the painters Zeus and Parrasio, the former was so skillful in drawing bunches of grapes that the birds themselves were attracted to them; the latter, in turn, drew a sheet which seemed to cover a painting so realistically that Zeus himself was deceived by it.

Likewise, as described by Nicholas Negroponte, adding realism to an artificial system may sometimes have very strong effects on man too. When in the 1970s one of the first teleconferencing systems was designed in order to make the emergency procedures of the US Government more efficient, a device was added to it, by means of which a moving plastic head indicated the person who was speaking at every moment, for instance the President. The result was that

... video recordings generated this way gave a so realistic reproduction of the reality that an admiral told me that those talking heads gave him nightmares (Negroponte 1995)

In the above-mentioned examples and, overall, in the great intellectual achievements in painting during the Renaissance, it is very clear that the deceptive and ‘illusory’ component of the artificially reproduced things, i.e., ‘fiction’, is generated at different levels and with seemingly diversified meanings. Indeed, while in the case of painting the fiction is an intrinsic aspect of the object, in the case of the reproduction of the President’s head cited by Negroponte, it is a secondary feature of the audio reproduction of his presence.

The famous desperate plea of that great sculptor who turned to his work and asked “Why do not you speak?” reinforces this point and the definition itself of naturoid we are proposing here. Actually, a naturoid, as an artificial attempt to