The Coding of Nature and Art:
Aristotle's Mimesis Revisited

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On this auspicious occasion of the inauguration of Code Biology as an academic discipline, it is only appropriate for the man who has conceived of his brain-child and christened it to introduce the concept. And it is to Professor Marcello Barbieri that I owe a debt of gratitude for this *rite de passage*. Not a biologist by training, but arguably a veteran semiotician, I shall first attempt to rehearse a few commonplaces of the thorny issue of 'code' by referring to a discursive tradition that links two prominent semioticians, Umberto Eco (1976, 1984) and Barbieri (2003, 2013) -- each in his own right and both being Italian a rather happy coincidence -- and then try to examine some Aristotelian texts to see how the first biologist and semiotician in the West had encoded Nature (ψυσις, *physis*) and Art (τεχνη, *techne*).

The precursor of biosemiotics, Jakob von Uexküll (1864-1944), never used the word 'code', nor, for that matter, did Ferdinand de Saussure (1857-1913) discuss it except once in passing: 'le sujet parlant utilise le code de la langue' (1916), suggesting that code is systematic like language. Louis Hjelmslev (1899-1965) refers to code briefly as the 'medium' of a text, e.g., 'flag code', 'jargon and code' (1961 [1943]), 'a code of special conventional signs', such as 'Morse code' (1970 [ca. 1941]). Uexküll's description of the interaction between receptor and effector in the functional cycles can be encoded to represent an elementary semiosis, involving a basically monoplanar codification. Advances after him, in particular, cellular biology and molecular biology, when coupled with semiotics, may shed light on his unfinished project. However, to date not much has been done in this regard, but the process of signification is often prematurely shifted from syntactic (i.e., formal) code to semantic code (Chang 2005).

Barbieri's definition (2003) of code as 'a set of rules that establish a correspondence between two independent worlds' (Barbieri, 2003: 94) seems a bit too general for biological specificity, but it identifies the fundamental principle of equivalence that governs inter-systemic relations. The examples he gives, Morse code, traffic lights, and language, do connect one system with another though they may not belong to the same order of signification. The author further provides a biological instance to illustrate code as an operative category. It means the existence of a real organic code is based on (and can be inferred from) the existence of organic molecules--called adaptors-- that perform two independent recognition processes. In the genetic code the adaptors are the transfer RNAs, but it will be shown that adaptors also exist in splicing and in signal transduction, which means that there are at least other two organic codes in real life (Barbieri, 2003: 93).

Barbieri's organic codes are presumably an advancement of the genetic code, which bridges the world of nucleic acids and that of proteins through the mechanisms of transcription and translation. There is no doubt that the genetic code involving the transcription process from DNA to RNA qualifies as a *bona fide* code, but as Eco (1984) observes, it is characterized by 'a process of steric stimuli' (Eco, 1984: 183) in which 'every element … interprets a previous one, and, in doing so, makes the process grow' (Eco, 1984: 184). In terms of Peircean interpretation, it is a case of semiosis, but not unlimited, and the kind of exclusive reliance on the internal syntax without semantic correlation is *monoplanar* and what Eco terms an *s-code*

(1976: 36-40; 1984: 169).   More or less in the same way Barbieri questions Shannon's 'sequence information' as purely syntactic and non-semantic and, as such, has limited relevance to biology (Barbieri 2013: 39).

The organic code, especially in the plural form, formulated by Barbieri reminds one of the meta-language of code-duality made famous by Jesper Hoffmeyer and Claus Emmeche (1991) since its coinage more than a decade ago. What constitutes the duality? They are two different 'codes': one digital and the other analog (Hoffmeyer and Emmeche, 1991: 126). But a little further, the two codes are seen to acquire different appellations: the digital is a language, but the analog is 'reality' (Hoffmeyer and Emmeche, 1991: 128). If one were to talk about the genetic code only, it would be much easier because it can be digitalised and more akin to a mathematical system. But accounts for life (and therefore semiosis) become difficult when that explicitly formalised genetic code is coupled with a vague analogical code. It is from the organic code(s) of life that Barbieri has developed his 'code paradigm' (2013: 35). Here one may raise the question on the relationship of digital and analogical codes. It seems the organic code is a product of their conjunction, but more recently Barbieri (2013: 43) has attributed the digital code to life and the analog code to chemistry: 'It is the divide between the analog world of chemistry and the digital world of life....' Adopting the linguistic model, one may envisage a hierarchy where the digital versus analog code serves as the primary denotative coding system and the organic code a higher secondary connotative system. For a survey of recent developments of organic codes, I refer to the documentation of Stefan Kühn in his thesis (2014), supervised by Hofmeyr and inspired by Barbieri.

Without further ado in a *terra incognita*, I will now wrap up my random references by pointing out a major distinction between biological codes and linguistics-based cultural codes. Whilst both can be said to deal with the phenomenon of signification, the former operates in an objectively observable closed circuit and does not involve human communication as phenomenological 'intentional act', i.e., the participation of human agents in encoding and decoding information unless we take the agents to be laboratory researchers who interpret autonomous molecular processes. Eco may term these processes signaling or signalisation of s-codes rather than semiosis. Or otherwise, the addresser and addressee of a text--being a product of the interaction of code and message--can be only members of a Thomas Kuhnian scientific community subscribing to the same set of beliefs and praxis. In science studies, there is no speaking subject (*le sujet de l'énonciation*), but only the subject matter discussed (*le sujet de l'énoncé*) (Jakobson 1957. Qtd in Eco 1979: 10).

Let me allude to a few observations made by Eco in his 1976 book, *A Theory of Semiotics* before proceeding to the second part of my paper. To Eco, for the over-simplified notion of 'sign' should be substituted the Hjelmslevian use of linguistic 'sign-function', which accounts for the correlation between an expression and its content (1976: 4), and code is thus 'a repertoire or a system of sign-functions' or a set of 'rules of signification'. Following him, Thomas A. Sebeok and Marcel Danesi's (2000) suggest code to be a 'system of signifying elements, which can be deployed to represent types of phenomenon in specific ways' (Sebeok and Danesi, 2000:191). Accordingly, Barbieri's description of the 'linear and digital sequences that direct the synthesis of molecules' (2013: 43) can be an example to illustrate signification. A crucial question is then how codes organise signs (1976: 49) or whether 'codes provide the rules which *generate* signs' or 'the conditions for a complex interplay of sign-functions' (1976: 56). Simply put but without exaggeration, one could say that code provides a meta-semiotics that serves to model the world of signs as object-semiotics and thus make scientific knowledge possible (1976: 57). Whether the system is an interpreting meta-system or an interpreted object-system, they are both encoded in and dependent on language. For instance, Eco identifies seven elements of codes and sub-codes on the expression level: (1) basic dictionary, (2) rules of co-reference, (3) contextual and circumstantial selections, (4) rhetorical and stylistic overcoding, (5) common frames, (6) intertextual frames, and (7) ideological overcoding (1979: 14), all of which are linguistic and discursive conventions that make human communication possible, but none of which are available or relevant to biological coding which enjoys autonomy if without violent human interference.

Even though the concept of coding is not traceable to dates prior to the rise of modern linguistics and information science, as far as semiotic modelling is concerned, it is perfectly legitimate to revisit the Corpus Aristotelicum in terms of the modern concept of sign and the related concept of code. Take Eco's *A Theory of Semiotics* for example. In addition to its extensive critiques of existing literature up to the early 1970s, the book ushers in the author's further investigation into ancient and medieval speculations on sign in his

Semiotics and the Philosophy of Language (1984), in particular the Aristotelian-Porphyrian classification of knowledge based on binary opposition, both *de dicto* and *de re* and the inverted genus-species tree. In the following pages I shall examine how Aristotle applies his analytical tools to his studies of both Nature and Culture, in particular, poetic genres in *Poetics*, animals in *History of Animals*, *Parts of Animals*, and various phenomena of human life in the seven short treatises under the name of *Parvu Naturalia*.

Through post-classical and medieval institutionalisation, the Aristotelian corpus is divided into four groups, based on the philosopher's own tripartition of knowledge as (1) the physical episteme, (2) the practical episteme, and (3) the productive episteme, and rounded up by the addition of a fourth group of his logical writings, known to us as the 'organon', and thus being upgraded to be the first kind in the corpus. Aristotle's statement about knowledge division in his *Metaphysics* runs as follows: 'There is a science of nature (περὶ φύσεως ἐπιστήμη, peri physeos episteme), and evidently it must be different both from practical (πρακτικῆς, practikes) and from productive science (ποιητικῆς, poietikes). For in the case of productive science the principle of production is in the producer and not in the product, and is either an art (τέχνη) or some other capacity (δύναμις, dynamis)" (*Metaph*. 1064a10-14). The emphasis on the role of producer suggests human manipulation in language use, e.g., in rhetoric and poetics, and thus serves to distinguish Art from Nature. The philosopher's envied attempt at embracing encyclopedic knowledge was to have far-reaching influence, and his modern descendants include John Locke and Charles Sanders Peirce, founders of the doctrines of sign.

For the present context, a few observations can be made regarding Aristotle's classification of knowledge. First, Nature (*physis*) and Culture (*techne*) are to be distinguished, and they are dealt with respectively by theoretical speculations and practical action '[f]or the end of theoretical knowledge (θεωρητικῆς, theoretikes) is truth, while that of practical knowledge (πρακτικῆς) is action' (*Metaph*. 993b20). Second, whether the knowledge we quest for covers the physical world of Nature or the practical and productive action of Culture, there should be initially an identical and unified method of research, that is, a meta-semiotics. Third, there are other conceptual and operational links, that is, meta-semiotics, between Nature and Culture, mimesis being one of them. I shall deal with this last issue later, and for now let me dwell on the problematic unified methodology which Aristotle envisages and argues for throughout his writings, and let me begin with a presumably 'later' work in the category of life science (natural philosophy) rather than the six works on logic. In *On the Soul* (Περὶ Ψυχῆς, peri psyche, [*On Vital Life*]), such a method is proposed in the following way.

The knowledge of the soul admittedly contributes greatly to the advance of truth in general, and, above all, to our understanding of Nature, for the soul is in some sense the principle of animal life…. To attain any knowledge about the soul is one of the most difficult things in the world [amounting to question of life]. As the form of question which here presents itself, viz. the question "What is it?", recurs in other fields, it might be supposed that there was some single method of inquiry applicable to all objects whose essential nature we are endeavouring to ascertain (as there *is* for incidental properties the single method of demonstration); in that case what we should have to seek for would be this unique method. But if there is no such single and general method for solving the question of essence, our task becomes still more difficult; in the case of each different subject we shall have to determine the appropriate process of investigation. (402a5-7; 402a10-18)

Aristotle seems deliberately ambiguous in his rhetorical question as to the singularity or plurality of method. But immediately after posing the question(s), he suggests the procedure of enquiry to be an ontological one on definition, as is consistent with his enquiries into the nature of other things.

First, no doubt, it is necessary to determine in which of the *summa genera* (γενῶν) soul lies, what it *is*; is it "a this-somewhat", a substance, or is it a quale or a quantum, or some other of the remaining kinds of predicates which we have distinguished? Further, does soul belong to the class of potential existents, or is it not rather an actuality? Our answer to this question is of the greatest importance. (402a23-27)

One should make allowance that the question Aristotle posed here as essential and universal to human knowledge is a rather preliminary if primitive one of epistemology and ontology, i.e., 'What is it?' bearing little relevance to the modern concept of scientific enquiries. In fact, his research method to tackle this question is basically deductive logic coupled with occasional empirical observations. The core of his deductive logic is the reasoning process involving definition, proposition and argument. The most succinct expression of his methodology is without doubt in book 2 of his *Posterior Analytics*;

'We seek four things: the fact, the reason why, if it is, what it is.' (89b21). To illustrate the four things, Aristotle gives the following examples: (1) the fact, e.g., whether the sun is eclipsed or not; (2) the reason why, e.g., why the sun is eclipsed and why the earth moves; (3) if it is, e.g., if a centaur or a god is or is not; (4) what it is if it is, e.g., 'What is a god?' 'What is a man?' (89b25-35).

For our purpose, two theoretical issues can be raised by the four questions Aristotle postulates. Firstly, (3) and (4) amount to the problem of definition, and definition implies the principle of equivalence governing the two parts that constitute a definition, namely, *definiendum* and *definiens*. The relationship between the two sides is analytical, tautological, co-conditional, and if you like, 'metaphorical' (*A≡B*). It is based on what Eco terms the 'dictionary' model, as against the interpretative and discursive 'encyclopedia' model. Secondly, definition involves the logical status of the substance defined, its generic identification, and differentiae, and consideration of which gives rise to classification and taxonomy, as evidenced by the Aristotelian- Porphyrian tree (See Figures 1 and 2). All the four questions boil down to the fundamental question of definition, from which is derived demonstration. How does one define a thing, or more precisely, a substance? Aristotle's coding consists of the continual division of a substance so as to identify the genus it belongs to by virtue of its differentiae which can be either essences or accidents. The method of generic differentiation is used throughout his writings and I will give only some dozen examples picked up at random.

(1) 'The differentiae of **genera** which are different and not subordinate one to the other are themselves different in kind.' (*Categories* 1b16)

(2) 'The **species** in which the things primarily called substances are, are called *secondary substances*, as also are the **genera** of these **species**. For example, the individual man belongs in a **species**, man, and animal is a **genus** of the **species**; so these—both man and animal—are called secondary substances.' (*Categories* 2a11-18)

(3) 'Well, of the things which belong always to something, some extend further—yet not outside its **genus**." (*Posterior Analytics* II.96a23)

(4) 'When you are dealing with some whole, you should divide the **genus** into what is atomic in **species**' (*Posterior Analytics* II.96b15-17)

(5) 'Now every proposition and every problem indicates either a **genus** or a property or an accident—for the differentia too, being **generic**, should be ranked together with the **genus**.' (*Topics* I.101b17-24)

(6) 'Nothing, then, which is not a **species** of a **genus** will have an *essence* – only **species** will have it, for in these the subject is not thought to participate in the attribute and to have it as an affection, nor to have it by accident … (*Metaphysics* 1030a11-14)

(7) '… for there is one sensory function, and the controlling sensory organ is one, though differing as a faculty of perception in relation to each **genus**, e.g., sound or colour …' (*On Sleep* 455b20-22)

(8) 'We find this distinction [between length and brevity of life] affecting not only entire **genera** opposed as wholes to one another, but applying also to contrasted sets of individuals with the same **species**. As an instance of the difference applying to the genus I give man and horse … while within the **species** there is the difference between man and man … ' (*On Length and Shortness of Life* 465a3-7)

(9) [Regarding the method of approach,] 'we are first to deal with the common or **generic** characters, and afterwards to take into consideration **special** particularities; or whether we are to start straight off with the particular **species**.' (*Parts of Animals* 639b4-6)

(10) 'I propose to speak not only of poetry [i.e., as **genus**] in general but also of its **species** and their respective capacities … Epic poetry and tragedy … are all, viewed as a whole, modes of imitation. But they

differ from one another in three ways, either in their means, or in their objects, or in the manner of their imitation.' (*Poetics* 1447a10-17)

(11) 'Metaphor consists in giving the thing a name that belongs to something else; the transference being either from **genus** (γένος) to **species** (ειδος), or from **species** to **genus**, or from **species** to **species**, or on grounds of analogy.' (*Poetics* 1457b7-9)

The above quotations illustrate clearly Aristotle's concept of genus and differentiae. It was later developed by the late classical Porphyry (fl. 3rd century) in his introduction to *Categories* (Porphyry 2003). Five existents -- genus, species (eidos), property, differentia and accident -- enter into intricate relationships in formulating definitions. According to Eco, Porphyry's rendition of Aristotle's into 'the form of a tree', probably to portray 'a Neoplatonic chain of beings' (1984: 58), is 'untenable' (1984: 46).

The next figure created by Eco (Fig. 2.4 in Eco 1984) shows, as the diaeresis (division) continues, man and god, or horse and cat, cannot be distinguished from each other because the tree cannot account for differentiae, e.g., man's differentia of 'mortality'.
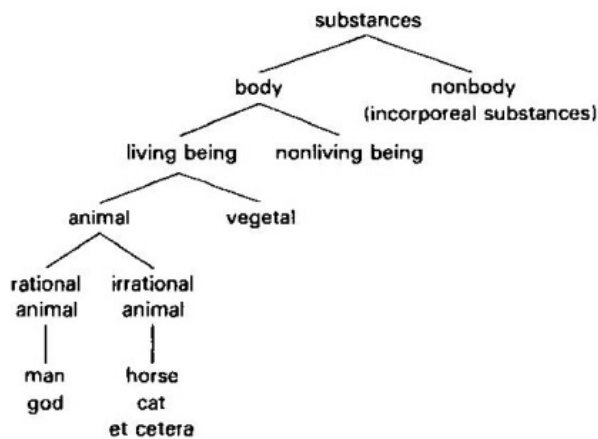

FIGURE 2.4

Other logical problems of the tree include redundancy and vagueness. For instance, the same differentia can encompass more species; the same couple of differentiae can occur under more than one genus; different couples of differentiae can be represented under many genera by using the same names; and '[i]t is an open question how high in the tree the common genus can be in respect to which many subordinate genera can host the same differentiae' (1984: 64). Therefore, Eco provides an alternative tree which is more flexible, explanatory – even of possible worlds -- and open to alternative hierarchies (the figure number is the original).
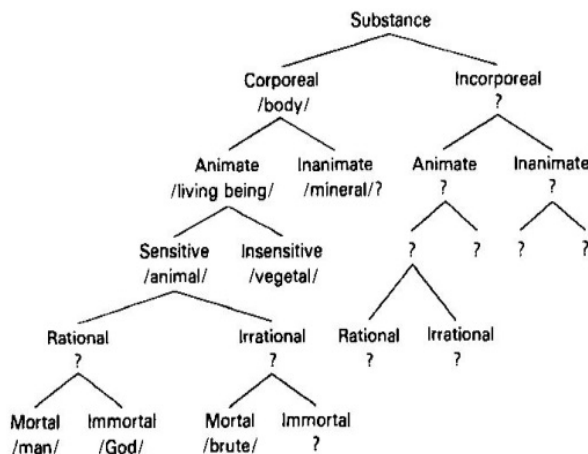

FIGURE 2.7

One can certainly agree with Eco that 'no bidimensional tree [is] able to represent the global semantic competence of a given culture' (68) and accept his multidimensional network model Q as a more feasible alternative, where the Deleuzian and Guattarian rhizome creeps in to undermine the Porphyrian tree (81). But it is the 'linguistic ghosts' (65-66) of genus and species, when fully textualised and contextualised, following the encyclopedia mode, that serve to structure Aristotle's *Poetics* -- in a top-down rather than a bottom-up model.

Let's take another look of quotation 10 from the *Poetics*:

(10) 'I propose to speak not only of poetics (ποιητικης = 'making', not 'poetry') in general (as **genus**) but also of its **species** (ειδων)* and their respective capacities … Epic poetry and tragedy … are all, viewed as a whole, modes of imitation (μιμήσεις). But they differ from one another in three ways, either in their means, or in their objects, or in the manner of their imitation.'

The quotation is Bywater's translation in the Revised Oxford Translation, with one minor revision in 'ποιητικης' for I believe the word 'poetry' is generically misleading.

Eco says Aristotle did not use 'species' because the species 'cannot be predicated of anything' (58). This is quite removed from the truth, given the fact that 'genos' and 'eidos' – Aristotle could not have known Latin, i.e., 'Small Latin and less English!' -- as hyperonym and hyponym on the lexico-semantic tree can be both predicated through syntaxisation and discursivisation, that is, language mapping. To me, the word 'species' – most probably unknown to Porphyry himself -- is an unfortunate Latinate coined by later commentators of *Categories* and *Isagogy* as well as the modern nomenclature system popularised by Linnaeus' binomial system.

As the above quotation shows, the philosopher treats *poiesis* -- defined by the mode of *mimesis* -- as a *genos*, which can be divided into subordinate *eidon*, such as tragedy, comedy, epic, pipe and kithera music, mime, Socratic dialogue, etc. The differentiae that separate one species of artefact from another belong to three categories, namely, the media (e.g., diction or rhythm), the object (e.g., plot or character) and the mode (e.g., narrative or dramatic) of mimesis. Thus we have arrived at a descending tree -- or stratification system in modern critical parlance -- as follows, and other derived trees devoted to differentiae proposed by Lubomír Doležel (1990: 18-21).
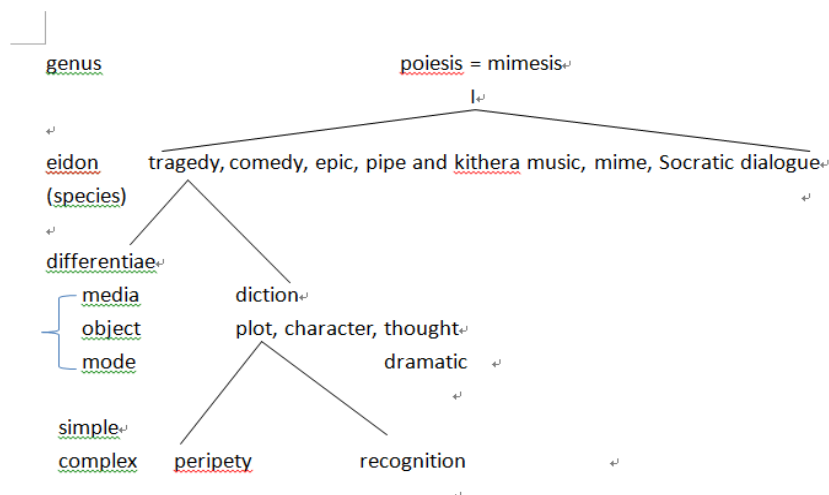
Furthermore, let us consider the intricate relationship between genos and eidos in the differentia of 'media', namely, 'diction'.

(11) 'Metaphor consists in giving the thing a name that belongs to something else; the transference being either from **genus** (γένος) to **species** (ειδος), or from **species** to **genus**, or from **species** to **species**, or on grounds of analogy.' (*Poetics* 1457b7-9)

The same descending hierarchy applies to the lower-level 'linguistic ghost' of metaphor which is an 'accident' in 'diction' as essential 'property'. Here one notices Aristotle's freedom in encoding this important quale of poetic language. In fact, his discussion of diction uses both a top-down and bottom-up models.

One may be able to conclude at this point. Porphyrus' *Isagogy* was originally meant to elucidate Aristotelian categories and definition. The tree that bears the Neoplatonist's name remains a crude taxonomy where names and concepts are loosely used and which fails to meet the challenge of rigorous semantic analysis. As such, it has limited pragmatic functions for all its popularity in history, e.g., its impact on the Linnean nomenclature. However, for Aristotle, the genos-eidos formula has become a useful tool in syllogistc demonstration and eventually develops into his mereology that deals with knowledge's part and whole relationship.

Furthermore, from time immemorial, in fact, before Adam was able to delve and Eve to spin, the tree has become an obsession in the history human imagination. From the archetypal Tree of the knowledge of good and evil and the Tree of life in the Genesis, history has never failed to witness an infinite host of arboreal lovers popping up from time to time, including Porphyry, who try to encode knowledge in terms of tree visualization. To mention only a few, Carolus Linnaeus's (1707-1778) classification of life, Charles Darwin's (1809-1882) inverted evolutionary or phylogenetic tree, Saussure's resort to a visualised 'real' tree to illustrate the linguistic sign of 'arbor' and 'arbre' and painted year rings to illustrate the relationship between synchrony and diachrony (1968), Noam Chomsky's (1928-) syntactic tree, and Maturana and Varela's popular tome, *The Tree of Knowledge: The Biological Roots of Human Understanding* (1987, 1992), which has come full circle, taking us back to the beginning of life and knowledge.

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