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# THE POETRY AND THE PROSE OF SCIENCE*

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ABSTRACT

A historical review of the relationships between art, literature and science is briefly presented. It shows that the common feature between these different types of knowledge is the emotional involvement that is present in the artistic as well as in the scientific creativity. It is then suggested that scientific teaching should grant more importance to the *course* or process of knowledge elaboration, rather than to its results, and to acknowledge not only its literary and historical interest, but also its scientific pertinence. Operative Epistemology may be an interesting way to explore, among other characteristics, the aesthetics of theory construction.
*Keywords: aesthetics, beauty, complementary, elegant, ethics, mood, Operative Epistemology, poetry, prose, science.*

## 1 SCIENCE AND POETRY

The pretended antinomy between science and poetry, considered today, as a banal matter of fact, taken for granted, is rather an ideological construct that has only recently affected our contemporary culture. In fact, the opposition between the warm delicacy of poetry and the cold reason of science arose only around the 18th century, and in particular, following the rapid development and wide vulgarisation of Newton's physics – as well as his consequent role in political affairs. The dispute between arrogant scientism and humanist tradition was virulent at that time: e.g. the English romantic poet John Keats accusing Newton of destroying rainbow poetry by explaining the mechanism of its formation. Soon after, another English romantic poet, Samuel Coleridge, maintained that poetry was the antithesis (if not the ... antidote!) of science.

Still, since the origins of our civilisation, poetry, prose and science have always been, for tens of centuries, indissolubly bound. In the *skhole*'s tradition of the Hellenic classical epoch, *episteme* (abstract knowledge), *tekhne* (operative knowledge), as well as *arete* (ethical knowledge) were considered to be the three indissociable faces of effective understanding. In other words, knowing something, knowing how to do it, knowing if it is ethically right as well as knowing how to explain it with poetical elegance, were considered the four basic competences of every real great master, the four conditions of an authentic *empeiria*.

The art of drawing, of poetical expression and of prose, has always been considered, since the Renaissance, legitimate ways of exploring and understanding reality, as valid as scientific investigations. In fact, art and science have intimately collaborated in the formation of fundamental knowledge, contributing to the construction of modern scientific disciplines.

One only has to think how sculpture, painting and the art of drawing played a crucial role in the construction of anatomic knowledge, as testified by the many notes of Leonardo da Vinci and also, a few decades after his death, by *De humani corporis fabrica*, published in 1543 by the Flemish physician Andreas van Wiesel – alias Vesalio – and adorned with many artistically inestimable anatomic tables, painted by a disciple of the famous Italian artist Tiziano. It is interesting to notice that in the same year 1543, Nicholas Copernick's work *De revolutionibus orbium coelestium* was also published.

At the same time, between 1530 and 1550, the first illustrated catalogues on plants and animals were published, prolegomena to botany and zoology: *Herbarum vivae icones* by Otto Brunfels,

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*De historia stirpium* by Leonhart Fuchs, and *Historia animalium* by Konrad Gesner – to quote only the better known – all illustrated with precious pictures, perfect from the scientific as well as the artistic point of view.

When artistic expertise is combined with the precision of scientific research, this happy combination results in the elaboration of new theories, or makes the discovery of new realities possible – realities that would have otherwise been unnoticed. Leonardo da Vinci is obviously the most powerful example, but there have been other famous 'scient-artists' as well: Louis Pasteur's expertise in portraiture, sensible to every irregularity that may disturb the symmetry of a face, led him to notice, first of all, the enantiomorph characteristics of crystals; and Galileo's familiarity with the *chiaroscuro* helped him to discover that the moon's spots could not be other than shadows projected on the surface of the satellite by large mountain chains.

Naturally, in these reciprocal fertilisations between art and science, the iconography, the pictured image, has often had a preponderant role over the literary expression, the 'written art', whose irreducible ambiguity can hardly compete with the univocal precision of the graphical sign. Leonardo himself, an undisputed master in integrating pictures and words, was very conscious of that fact: 'Writer, which letters would be as perfect as this image? Do not be anxious with things pertaining to the eyes, while trying to make them pass through the ears: you will be surpassed by the work of the painter in any case' [1].

Elegant literature and strict scientific demonstration were for long considered not only to be two modalities of exploring reality, both valid and legitimate, but also two communication strategies that may harmoniously coexist and complement each other. Perhaps the most famous example is *De rerum natura* by Lucrezio: an undisputed poem but also, at the same time, a very effective way of explaining the difficult concepts of epicurean physics. Many years later, a similar attempt was made by Edgar Allan Poe with his *Eureka: an essay on the material and spiritual universe* [2], whose dedication is worth quoting: 'To the few who love me and whom I love/to those who feel rather than to those who think/to the dreamers and those who put faith in dreams as in the only realities/I offer this book of Truths, not in his character of Truth-Teller, but for the Beauty that abounds in its Truth, constituting it true/To these I present the composition as an Art-Product alone:/let us say as a Romance; or, if I be not urging too lofty a claim, as a Poem'. In this extremely elegant essay, the author exposes the latest discoveries concerning cosmology at that time and anticipates the question of the 'great unification' theory of the different forces that govern the physical world.

Furthermore, narration has always been a privileged way of expression and communication by great scientists. Besides the Greeks, whose written teachings also established the base of Western literature, we may remember Omar Kayyam, Galileo, Francesco Redi, Bachelard, Primo Levi and many others.

But the confirmation that poetry and science can be complementary, and sometimes accomplices, most often in popularisation strategies, does not necessarily imply that science could contain poetry, nor that one may speak of a 'poetry of science'.

Much has been said about aesthetics in science, dating back to antiquity, and today the discussion continues as the classical anthology *On Aesthetics in Science* by Judith Wechsler, shows in a very authoritative way [3].

Some consider the aesthetic value of science to be strongly linked to, or even a consequence of, its ethical implications. A recent example of this approach is the book *Ethics and Aesthetics of Science*, by the famous biochemist Alfonso Maria Liquori [4].

Others, associating beauty and truth, consider that science cannot but be aesthetically beautiful. Well-known supporters of this thesis were Einstein, Dirac, the above-mentioned Poe and many other scientists and scientific popularisers whose important testimonies have been recently reviewed by

Graham Farmelo in his essay *It must be beautiful : great equations of modern science* [5]. Among the equations that appear in this volume, the core of beauty is constitutive of the Quanta's theory, but we also find some other elegant formula; it is interesting to note that, generally speaking, the common characteristic of formulas described as 'elegant' is their essential simplicity.

But what about poetry in science? Since the time of Lucrezio, many poets have narrated science. However, this is not poetry in science but poetry *about* science.

Some famous scientists have been involved with poetical writing. Among the several anthologies of poetry and short literary essays written by well-known scientists that have been published are Robert L. Weber's famous *A Random Walk in Science* [6]; John Heath Stubbs' and Philip Salaman's book *Poems of Science* [7]; or the more recent Maurice Riordan's and John Turney's *A Quark for Mister Mark : 101 Poems about Science* [8]. In these cases too, however, it does not seem appropriate to talk about 'poetry in science'; in fact it is poetry *from* science, written by scientists, most often on the sidelines of their main scientific occupation. Even if sometimes the specific topic of their work is embedded in the choice of the poetical expression, it plays, however, a secondary role, collateral to the principal theme on which the poetical composition is set up. This is generally one of the 'classical' themes of poetry: love, nature's beauty, the soul's moods, experiences of life, etc.

## 2 THE POETRY OF DISCOVERY

So, when is it appropriate to speak of 'poetry in science'? Probably, one has to turn to the mood states and emotions that created the scientific discovery, rather than to the poetical writing itself. The real question is: if poetry is the fruit of a particular contemplative mood, rich in expectations, amazement, emotions and empathy so strong that they push the linguistic expression out of its common admitted rules – and therefore become poetry – then, in the daily work of scientific research, what could have analogue significance, awake similar passions, surprise and amazement?

Eugène Martial Bataille wrote in his *Traité des Machines à Vapeur* in 1847 [9]: 'Isn't invention the poetry of science? Every great discovery holds the indelible trace of a poetical thought. One has to be a poet to be able to create. I am convinced that if the powerful engines, the source of our current production and industry, needed radical changes, these would be made by men with imagination, and not by men with technical expertise only'.

A few years earlier, in 1840, the famous chemist Sir Humphrey Davy wrote [10]: 'The contemplation of the laws of the universe is connected with an immediate tranquil exaltation of mind, and pure mental enjoyment. The perception of truth is almost as simple a feeling as the perceptions of beauty; and the genius of Newton, of Shakespeare, of Michelangelo, and of Händel, are not very remote in character from each other. [...] Discrimination and delicacy of sensation, so important in physical research, are other words for taste; and the love of nature is the same passion as the love of the magnificent, the sublime, and the beautiful'.

This is an interesting path – along which it may be possible to find the real poetry in science. This is the path of clever invention, of important discovery, which may suddenly and unexpectedly surprise the researcher, who methodically follows its traces, leaving him astonished and deeply moved.

The biologist, Richard Dawkins, seems to follow this same path. His literary talents have recently granted him the nomination of *Public Understanding of Science* (*sic*) by Oxford University – as we can easily appreciate in the introduction of his famous book *Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder* [11]: '... science is poetry, science must be poetry, it has a lot to learn from poets, and should use more poetical imagination and metaphor as source of inspiration'.

And of course, we should not forget the beautiful book by the famous Nobel Prize winner, astronomer Subrahmanyan Chandrasekhar: *Truth and beauty: Aesthetics and Motivation in*

*Science* [12], in which he compares the works of Shakespeare, Beethoven, Newton, Milne, and Eddington, indicating how the poetry of beauty is found in each creative process, be it artistic or scientific.

In fact, every analysis interested in scientific creativity agrees that the scientist's creative process presents almost the same characteristics as artistic creativity. This was the opinion expressed by the Gestalt psychologist Max Wertheimer, half a century ago, in his refined analysis of Einstein's work [13]. Fifty years later, Nersessian in his study about the notebooks of Faraday [14] expressed the same idea. As it is well described by Margaret Boden in her classic *The Creative Mind: Myths and Mechanisms* [15], or by Keith Holyoak and Paul Thagard in their recent essay *Mental leaps: Analogy in Creative Thought* [16], the scientist, in his more creative moments, turns to the seduction of the imagination to the fascination of the analogy and to the pleasure of being surprised by the unexpected.

Therefore, science is poetry – even if it is not expressed in a poetical way – in those privileged and exceptional moments when science temporarily bypasses its methodological rigour in order to achieve a surprised impression out of a metaphor's suggestion, an astonishment from an unexpected intuition or the beauty of an original reformulation.

It is invention that is poetry, because, finally, poetry is nothing else but the emergence of a really new knowledge: 'the majestic beauty of an unexpected comprehension' – also stated by Chandrasekhar (ibid).

## 3 SCIENCE AND PROSE

When, and in what sense, can we speak of 'the prose of science'? Certainly, a scientist uses prose to write an article or a book. But if we want to maintain for the term 'prose' a high literary sense, then we have to accept, alas, that the texts we read today in scientific journals, very rarely have the elegance that one normally expects from literary prose.

But this has not always been the case. Antiquity and Renaissance scientists used to exchange personal letters with each other, to discuss their discoveries; in these letters, they often emphasise the importance of the form as well as the elegance, adding some personal comments to the technical aspects of the scientific experiment, relating events or anecdotes that have accompanied their research work, with a large use of metaphorical expressions. At that time, the epistolary exchange was the only means of communicating scientific knowledge, and in these exchanges, mathematical formulas and poetical pictures, important findings and anecdotal notes could coexist without friction.

Then, with the diffusion of printing and the subsequent multiplication of specialised publications, scientific communication became more and more impersonal and disconnected from everyday life. Nowadays, the editorial rules that are imposed by most contemporary scientific journals require authors to avoid the use of personal pronouns, to avoid favouring one gender over the other, to limit the use of the subjunctive, to avoid metaphors and to prefer impersonal pronouns and expressions. Such strictures appear to be a fanatic as well as an unjustified process of depersonalisation and flattening of the scientific discourse, eliminating every sign of poetic ambition and all rhetoric forms. The result of this purification process is a text, which is far removed from poetry or prose.

Consequently, two channels of communication have emerged among scientific communities: the 'serious' one, and the 'officious' one. The former, where every literary attempt is banned, is rigorously controlled by the academic authorities and diffused exclusively by scientific journals and boarded publications. The latter, less 'serious', is more informal and reserved for private exchanges; it may sometimes come closer to literary prose.

Some famous examples of this second informal channel can be found in the published private epistolaries, as for example the one between John Roebuck and James Watt [17], where Watt complains,

in 'coloured' and animated language, about the inexperience of his workmen in the area of operating steam engines. Another well-known example is the correspondence between Wolfgang Pauli and Carl Gustav Jung [18], in which Pauli tells Jung about his secret perplexity and his fears regarding the scope of science and its limitations.

Presently, the true 'prose of science' is relegated to the no-man's land of unofficial, marginal and 'unimportant' writings of scientists or to published texts written for non-specialist readers. As a matter of fact, it is among these writings that we can find some works of real literary value, such as those by Stephen Jay Gould, Ilya Prigogine or the already mentioned Richard Dawkins.

The problem is that the ancient opposition, from the nineteenth century, between science and literature, still has a strong influence over the particular relationship one entertains with scientific knowledge, whose rigorous method is often connoted in terms of aseptic apathy, in opposition to the emotional and empathic involvement of literary works. We have learnt to question the scientific value of a report, if it contains too many signs of empathy or literary elegance.

Unfortunately, schools also contribute to maintain the distant and disconnected relationship with scientific knowledge, because at almost every learning level, scientific knowledge is presented exclusively in its officially established and finished form, doing away with the long and emphatic process of elaboration. Naturally, it is precisely in that long process, made up of verifications and errors, discoveries and deceptions, struggles and competitions, that one may observe the passion, the emotions, the aesthetics and the poetry of science!

## 4 REDISCOVERING THE PASSION AND THE BEAUTY OF SCIENCE

Nevertheless, it seems that in recent years, the narrative dimension of scientific discourse is attracting fresh interest, mainly because of the impact of the mass media on our culture. In fact, when the media want to communicate the great successes of modern technology and scientific development to a wide public, their peculiar need to dramatise events makes them lay emphasis on the passionate dimension of scientific research, thereby colouring scientists and inventors with the same attributes of the epical hero depicted in traditional classical dramaturgy.

We are currently rediscovering the biographies – and to a larger extent, if available, the autobiographies – of many 'heroic' scientists who have left a noticeable trace in the history of science and technology. Reading these narrations, sometimes of great literary value, one can truly grasp the passion and suffering involved in the rigorous researcher's work, and understand that aesthetics always plays a role in the logico-mathematical interpretation of scientific data. The epic endeavours of artists and scientists are indeed very similar.

Striking examples from the autobiographies of scientists include those of Albert Einstein, Carl Gustav Jung, Jean Piaget, James Watson, Max Planck, Joseph J. Thomson, Edward O. Wilson and Herbert Simon, to mention only the most famous. Others by less famous scientists are equally gripping, for example, that of Curt Herzstark, the genial inventor of the first mechanic portable calculator, the 'Curta', which carried out almost all mathematical operations including the most complex ones like root extraction through an ingenious process of sequential additions and subtractions.[19].

Indeed, reading these less known biographies makes one realise that there is no distinction, from this point of view, between 'minor' versus more 'important' biographies and that in every scientist's life, one will always meet the same passions, emotions and amazements that accompany every invention or discovery.

And now we come to a clue to help us identify what we may effectively call 'the prose of science': it is the *narration* of scientific work. Narration must have the elegance of fine prose; otherwise it loses its narrative value. By contrast, a simple description of research results will always remain a description, even if written in a flat and impersonal way.

Unfortunately, the obstinacy of focusing only on the final results, the official 'discoveries' of science, while neglecting the process that made them possible – an obstinacy that the school systems seem unable to give up – is also a perverse outcome of the academic evaluation of scientific knowledge, as it emphasises the mnemonic restitution of a list of items, as opposed to a well-documented narration of the morphogenetic process that led to the original results and inventions.

Scientific narration of the kind discussed here makes the real essence of a scientific discovery comprehensible to us in a more memorable and vivid way than formulas or demonstrations do.

In order to return the narrative and poetical dimensions to science and finally its real dignity, we should grant more importance to the *course* or process of knowledge elaboration, rather than to its results, and acknowledge not only its literary and historical interest, but also its scientific pertinence. 'The explanation of a phenomenon is to be found in its genesis, not somewhere else' – Jean Piaget often said.

Indeed, in many circumstances, the main problem in scientific research is not really to acquire or to increase knowledge, but much more to change its rules of use. And when the problem deals with the transmission, the reconstruction or the modification of a set of notions, then the determining factor is the nature of the *relationship* one entertains with knowledge and more generally with culture. This relationship appears as an intricate network of multi-level connections between logical operations, rhetorical figures, factual observations, ethical judgements, aesthetic seductions, contextual situations and economical decisions, where none of the properties of any part is fundamental, but each one emerges from the others [20]. Thus, any act of knowledge implies a modification of the cognitive, moral, practical and aesthetic relations that exist between the knower and the known. In other words, a system of conceptualisations cannot be built and used without the support of a system of values, and a system of values cannot be elaborated and accepted without the support of a system of conceptualisations.

Trying to formulate an 'objective' description of empirical facts 'as they are', for instance, is also an attempt to position oneself in a relation of dependence *vis-à-vis* fixed, definitive, 'official' knowledge. Trying to explore alternative hypotheses, constructing unorthodox theorisations or adopting different points of view, is at the same time an attempt to position oneself in a more autonomous relationship with knowledge, considered as a questionable and never-ending process.

It is evident from this point of view that the social dimension of knowledge, usually neglected by traditional epistemology, has to be taken into consideration. But in this respect, it must be clearly pointed out that, contrary to a common trend in contemporary social psychology, the social dimension is not to be considered a 'special' or a prominent factor: it is just one aspect amongst others and it cannot play a 'more explicative' role than other factors or aspects. In order to play a privileged explicative role, the social dimension should be considered as being an *outside* cognitive process: now, within a constructivist approach, this is clearly unacceptable because no object or situation can be considered pre-existing the knowing subject. The social dimension is an object of knowledge like all others: it is a *construction* of the activity of knowledge and therefore it cannot be a condition of this same activity.

We have to leave aside oppositions such as subject/object, reason/emotion, objective/subjective, perception/delusion, facts/theories, qualitative/quantitative, etc., and consider on the contrary that each pole is an active component of a double complementarity, in which the two sides are different levels of recursive processes where one term of the pair emerges from the other, and both contribute to the emergence of a new level of a wider process. Moreover, the wider process may in turn be seen as a new pole of a more encompassing complementarity, and so on. Such distinctions are no longer representations of an either/or duality, subsumed by a logic of negation; rather, these complementarities may help us to transform our ways of knowing towards an aesthetic vision of the world of which we are a part.

The methodological approach of Operative Epistemology – a research tool and educative strategy as well, developed by Fabbri & Munari since the 1980s [21–23] – is of particular interest for exploring from this perspective the process of theorisation. According to the Operative Epistemology, a theory must be seen not only as a set of abstract ideas, more or less connected together, but as a coherent system of conceptualisations, feelings, beliefs, strategies and actions with which a subject can provide an explanation of the world he lives and operates in. This coherent system, consequently, must be satisfying from a cognitive, moral, practical and aesthetic point of view. Otherwise, it must be discarded.

Studies on metacognition are generally oriented towards an improvement of the performances in problem solving; Operative Epistemology, instead, does not focus directly on performance, but attempts to elicit the *awareness* of the *relationship* one has with knowledge. Through the awareness of this relationship, the principal aim of a Laboratory of Operative Epistemology (LEO) [24] is to point out the complex network of heterogeneous interrelations that are involved. A LEO is thus not a place where one merely solves problems or speaks about knowledge; it is an occasion, beyond any dualism, fragmentation or reductionism, for *experiencing the adventure of discovering the pleasure of thinking*. As Gregory Bateson said: 'The rewards of such work are not power, but beauty' [25].

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