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## **HOW DO NEW IDEAS TAKE SHAPE? PART 1: EXPLORING WHAT ARTISTS AND SCIENTIST SHARE (AND WHAT NOT)**

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### **Abstract**

*Inspiration* designs an almost unexplained stimulus related to the way or process a new idea in the fields of art or science is conceived. *Method* is tightly tied to the processes followed by the scientist in his task, trying to convert a seminal idea into a new and successful scientific hypothesis. Although most people think artists have no method, it is widely accepted that scientists extensively use "the scientific method". Both ideas are misconceptions. Those mastering Art develop hard and conscious methods of work to achieve the results they are looking for, and scientists use a lot of different approaches to solve their problems and not a single "scientific method". Deep discussions about these subjects, although largely developed among epistemologists and philosophers, have seldom permeated to the artistic and scientific communities (most of whose members do not care at all about the processes leading them to new products and ideas), and are completely absent from the concerns of common people.

Everyday ideas about inspiration and method are not alike artists and scientists feel they do their work. In this contribution the concepts of *inspiration* and *method* will be explored along with several other relationships linking Science and Art and those who practice them. How Science improves the instruments and techniques of Art, how Art produces images that strongly contribute to the visual perception and learning of concepts that are too big or too small for the eye, or are just too abstract, how Sciences contributes to the investigation of the materials used by artists (authentication, historical and geographical assignment, etc.), are several of the items to be addressed.

A complementary view, absolutely necessary but which is absolutely out of the possibilities of this contribution, refers to what neurosciences and psychology can tell about how the human brain accumulates and processes information in order to establish new links between concepts, and to find or develop new ideas. The knowledge of how all these concepts (inspiration, method and neuropsychological aptitude) interact is the necessary background to develop not only artificial intelligence but also to go still further and create "technological creative geniuses" ... if they are supposed to be necessary.

## Introduction

Reflections about the links between Art and Science are not new to the e-Golem. In the previous meeting in Prague, two contributions, one by Giboda (2005) and the other by myself (Sellés-Martínez, 2005), explored the subject. In the following paragraphs, the first part of a longer contribution, several relationships linking Science and Art and those who practice them are going to be explored. How Science improves the instruments and techniques of Art, how Art produces images that strongly contribute to the visual perception and learning of concepts that are too big or too small for the eye, or are just too abstract, how Sciences contributes to the investigation of the materials used by artists (authentication, historical and geographical assignment, etc.), are several of the items to be addressed.

Names like Athens, Alexandria or Florence recall moments in History when creativeness produced not only works of Art that would last as archetypes for the following centuries, but also the times when Philosophy and Science reached remarkable heights. It was not uncommon, at those times and places, that the artist and the scientist coexisted in the same person. Art and Science seem to be divorced at present. Most people identify Art with freedom to express the artists' ideas and Science with rules and boring systematic work in the search for a new natural law. Separation between both areas is clearly illustrated by the fact that in almost every newspaper in the world, sections on Culture and Science are neatly separated, with only music, literature and visual arts meriting the label of Culture.

Is this difference so clear? Is the work of an artist really so different from what a scientist does?

These questions have been addressed many times since long ago, and this presentation aims in highlighting those points in which Science and Art converge and those where they diverge. *"Science and Art are only names, designing different things. To tell the truth they are inseparable"*, says Paul Valéry. *"The spirit of search and conquest is the supreme essence of progress. It characterizes all those who have devoted their lives to Art or Science"* says Pierre Teilhard de Chardin. These thoughts, coming from a man of letters and a man of science, far from showing profoundly divorced communities show that their activities share many things, in their nature and in their method.

Interesting indeed is the opinion of Thomas H. Huxley (1882). The efficient partner of Darwin, struggling for a more complete education and against the division of artistic and scientific worlds (at least at the time of school attendance), strongly remarks that "there are other forms of culture besides physical science, and I should be profoundly sorry to see the fact forgotten, or even to observe a tendency to starve or cripple literary or aesthetic culture for the sake of science. Such a narrow view of the nature of education has nothing to do with my firm conclusion that a complete and thorough scientific culture ought to be introduced into all schools". In his conference Huxley emphasizes the importance that learning about science has in the development of the personality of the youth, and points out the importance of developing observation and description skills that are *sine qua non* conditions for both, artists and scientists. Going back in time, Da Vinci says "When I am involved in

a scientific problem, I start registering a series of experiences, because my purpose is to define the problem in relationship with experience, and following that to demonstrate why bodies are compelled to act as they do. This is the method to be followed in all the investigations concerning natural phenomena”, a few sentences afterwards he recommends “to consult experience taking into consideration all cases and circumstances until the general rule imbedded in them can be extracted”. “Why are these rules good?” He asks, and answers “because they lead us to new investigations in nature and in the arts”. It comes out from these statements that one of the archetypes of Renaissance approached his scientific and artistic achievements in a similar way.

### Differences and similarities

Two other opinions on the subject can be quoted, this time coming from painters. One is the well know cubist Braque, who said “I love the rule that corrects emotion”, whilst Kozel (a contemporary artist living in Argentina who has worked in representations of the cosmos) argued that “Sometimes, artists go further on than scientists do”.

How can these two statements be interpreted? Braque reminds us that Art (at least at his times) could not exist without somebody mastering not only technique (“art” and “technique” were one and the same thing during Greek times) but also signs (or rules) mediating communication between artist and spectator. Art can not emotion in a selfish form, because it would not be understood by any other. In the same way science is not just the sprung of a new idea, it has to be communicable and demonstrable to become understood and accepted. Artists and scientist should master communication skills in their fields (what is completely different from mastering public relations), both should have a clear idea of what they want to communicate and must choose the best way to do so in order to be correctly understood and interpreted. The fact of how many people is able to understand the message if it is intrinsically difficult does not matter, what matters is that the difficulties should lie exclusively in the matter and never be caused by the language of the message.

Some troubles with vanguard art in the 20<sup>th</sup> Century are probably based in the fact that they lack what is in the basement of true Art and true Science: clear rules and understandable language. Several productions actually are to Art something like what astrology is to Astronomy, they share several external features but not the essentials. They are noisy, but not really sound. Can we really consider Art a painting that is not visually attractive and requires a hundred pages of explanations to be understood (if the jargon can be deciphered)? Can we consider literature something that only plays with the sound of words, and therefore only makes sense with converted into music when spoken, but has no effect when somebody reads them?. In the same way science is not only ideas: it is “understandable” and “demonstrable” ideas.

The statement from Kozel introduces us into what is probably the most important difference between Art and Science. The objective of Art is not to find out a datum, an accurate description of a fact or process, a measure that has to be equal to itself under same conditions no matter who measures it (things that are intrinsic to Science and the bases of its development). The work of Art is not offered as a scientific truth but only as a particular way (always original in the true artist) of looking at reality.

Where the geologists see the work of ice (U shaped valleys, moraines, eskers and other forms of glacial environments), where he interprets processes and phenomena that work on the substratum in order to model the present shape of the land, the artist sees shapes, volumes, colours and the play of light and shades that impact his emotion in a way he wants to share with us through the work of art: the painted landscape. He takes from the real world what he finds necessary for his work and does not care too much about the origin of the forms or about the degree of accuracy in their representation. It can be a photograph, a topographical landscape (as accurate as possible), an ideal landscape or an composition representing a psychological landscape, they are no matter for the scientist (with the possible exception of those historians of landscape that search for the modifications introduced in it during the last centuries, that would look at the work of art as a documents and not as such). The missing and alterations in the artistic representation are of value for the artistic message, but would ruin any illustration conceived with scientific purposes.

Both individuals, the artist and the scientist, anyway share several abilities necessary to succeed in their task. Both should, for example, have an acute capacity to see what appears in front of them, in the whole and in the details, to immediately find out what is essential and what is superficial. It is not by chance that a famous Academy in Italy was named “dei Lincei” (Academy of Lynxes), an animal famous for its powerful eyes. The ability to really see when looking at may be something one is gifted with, but it has to be trained and developed through exercitation to become significant. Artists and scientists can discover heterogeneity where common people will see only monotony. They share the capability to visually “cut” and separate all what is important for their objectives from what is not.

On the other hand, it has been pointed out many times, that one of the most neat differences between the products of artists and scientists is the “cumulative” character of Art and the “replacing” character of Science. History of Art is full of magnificent master works still recognized as such and still priced as such (it is common fact that most ancient works are many times much expensive that present days ones). On the other side, history of Science is full of discarded ideas, hypothesis and theories that no longer work. All this material is only interesting to historians of science and to philosophers, but is completely useless for present day science and technology. The pyramids are more important today than at the time they were built. The theories of Tales de Mileto, no matter they have been tremendous advances at his time, have no place in modern interpretation of the natural world.

What seems to be clear is that scientists have an inquisitive attitude, trying to explain facts and processes using laws and principles that have previously shown to be applicable to solve this kind of problems, whilst artists have an aesthetical approach, and wish to share how they perceive it. Each of them develops the necessary methods to go through scientific and artistic problems in order to successfully solve them.

## A history of fruitful cooperation

As mentioned in the beginning, art and science had run a long way together before knowledge attended such a large extent that it was impossible for a single man to make the attempt of covering it all. Increasing complexities in science and in art make the roads diverge, but many bridges connect, here and there, the fields of Science and Art, as a matter of fact, many new bridges are built every day and several examples can be seen in a special issue of Nature magazine (434, 17 March 2005) not by chance named “Artists on Science: Scientists on Art”. In the following paragraphs several links between Art and Science will be briefly explored.

### *Art in Science*

This item is strongly related to the finding of beauty in the forms of Nature. The same way beauty can be found in a flower, in an animal or in a landscape, it can be found in those images that, although being obtained from natural sources, are “mediated” by scientific instruments or methods of processing. This would be the case of microphotographs from tissues or rocks, but more complex and elaborated products -as those coming from magnetic resonance images of organisms or from seismic surveys of the subsoil- render magnificent images that can be regarded as Art as well as Science. Figure 1a shows a polished stone in which a landscape, closely resembling the one in Figure 1b can be easily identified (... or vice versa?). Books like “Das Geheimni der Steine” (Kern, 2005) and exhibitions like “Computer Geosciences as Art” organized by the Bakersfield Museum (Shirley, 1998) among many others developed by biologists, physicists, etc, clearly illustrate this point. Tens of Physics Today’s covers can also be presented as an outstanding example of this great aesthetic appealing of scientific imagery.

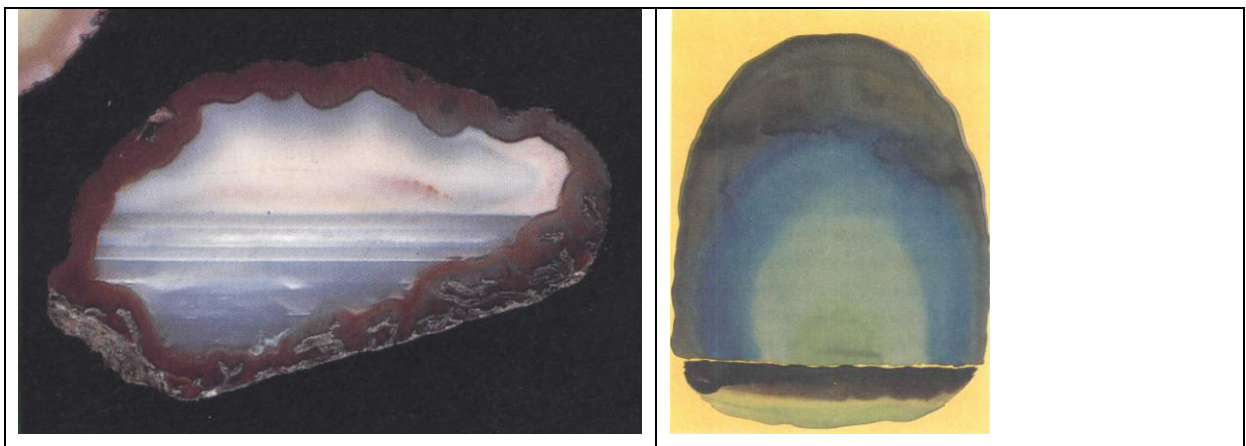


Figure 1: “Landscape agate” and a landscape strongly reminding an agate. a- An agate in the Collection of the British Museum of Natural History (Macpherson, 1989). b- Light coming on the plains II, by V. O’Keeffe (Amon Carter Museum, USA)

### *Science in Art*

Painters and writers, more than other artists have done, are in one way or another, the testifiers of their times and, as such, offer to their contemporaries and following generations the image of Science and Scientists that society has at a certain historical period. Differences in the representation (or description) of the life and findings of scientists and philosophers define how they are seen or interpreted by

their times or those following it (in the case of historical “reconstructions”). Famous pictures, like David’s reconstruction of the scene of Socrates drinking the cup of poison or Wright of Derby’s composition of people looking and listening at a scientific experiment, clearly show that most of the time, science has been regarded as a respectful activity (see Figure 2) and scientists considered as outstanding individuals, somehow particular, but respectable (see Figure 3), as shown by De Barbari’s portrait of the Renaissance mathematician L. Pacioli, the imaginary portrait of Newton by Blake or the many photographs of A. Einstein emphasizing his informal look.



Figure 2: Science as seen by society. a- “The death of Socrates” by David (Metropolitan Museum. b- “An Experiment on a bird in an air pump” Wright of Derby (National Gallery).



Figure 3: Scientists at work. Three epochs offer three different approaches, any of them ingenuous, each image carrying a strong message about scientists and their personalities. a- Luca Pacioli by J. di Barbari (Museo de Capodimonte), b- Sir Isaac Newton by William Blake c- Albert Einstein.

Portraying science and scientists in not the only way Art has seek into Science for inspiration. In the already quoted contribution by Sellés-Martínez, several forms of art closely linked to Mathematics have been mentioned. Going further on, artists have sometimes taken scientific subjects into their works. Figure 4 illustrates such a case.



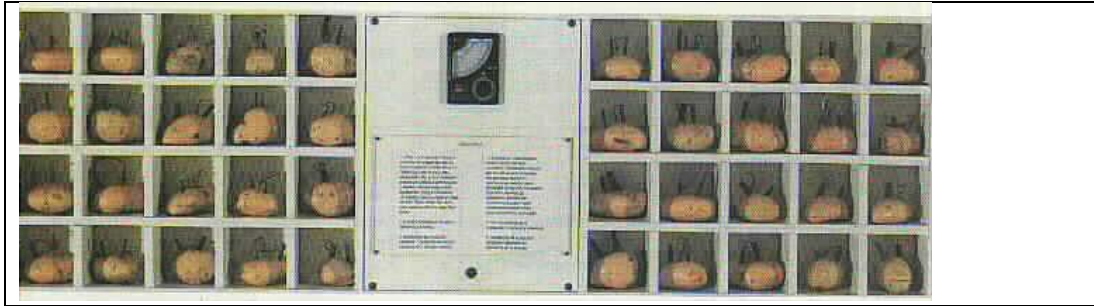


Figure 4: Works of Art inspired in scientific concepts and processes. “Analogy I” an installation by V. Grippo, includes potatoes, nails and a galvanometer to produce and measure an electric current (Museo de Bellas Artes de Buenos Aires).

### *Art as a Science*

This subject will be further explored in a future Part 2 of this contribution, but it can be said here that, most of the time, true artists whom are in search of new ways of expression and those who develop the needs of different forms or representation of artistic messages, get involved -consciously or not- in some kind of research or investigation. These tasks require, to be fruitful, the same organization and disposition of character that a scientific project does. Technological achievements, like new pigments or new techniques, the incorporation of new materials, the finding of a desired effect, all of them require systematization of practice, trial and error, reading and inquiring about, the same as a scientific research does in one or another step of its development. The work of impressionists or that of cubists, represented in Figure 5 by emblematic works, goes beyond what appears at first glance and has required hard systematic work to find their shape.



Figure 5: Lot of scientific work is hidden beside this apparently natural (a) or anarchic (b) paintings. a- “Waterlilies” by Monet (National Gallery) b- The blue mandolin, by Braque.

### *Science as an Art*

The idea that scientists found Beauty in their abstract constructions and their universal laws has long been addressed. “Creativity” and “inspiration” are terms that although most commonly applied to artists, are essential to scientific findings, and are virtues common to true scientists and artists, no matter what psychological and neurological processes could be involved in them. The need to find his own language (style, colours, harmonization, etc.) that makes any artist recognisable among thousands and differentiable from his colleagues can be paralleled by the need of the scientist to find new fields of research, still unexplored (or not yet with the new tools provided by technological advances) in which to express all his intellectual power.

### *Art in the service of Science*

Before the introduction of photography, Art was also the unique way to document scientific or technological facts, like the exhumation of fossils, the eruption of a volcano or how persons with different sicknesses looked like, but this documentary task is not the only thing Art can do for Science. Artistic design can help presenting data in a more attractive way and, more over, the application of the unpaired capacity of visual arts to help making models of what is inconceivably big or small or abstract is crucial at all levels of scientific communication, from papers to newspapers. Images mediate and facilitate the comprehension of things and concepts that would be hardly understood without their help. Terms like “pedagogical images” or “visualization of science” come from this reach interactive field devoted to “drawing knowledge” in order to make it clear. But be aware: one risk is usually undervalued with the use of visually attractive models: most people take the model for the real and, therefore, introduce in their understanding important conceptual mistakes. This is well known in the case of atomic and molecular models: most people think that multicolour balls models are in fact “amplifications” of the micro cosmos, what they surely are not. Figure 6 illustrates several of the many forms of art and design working for science.

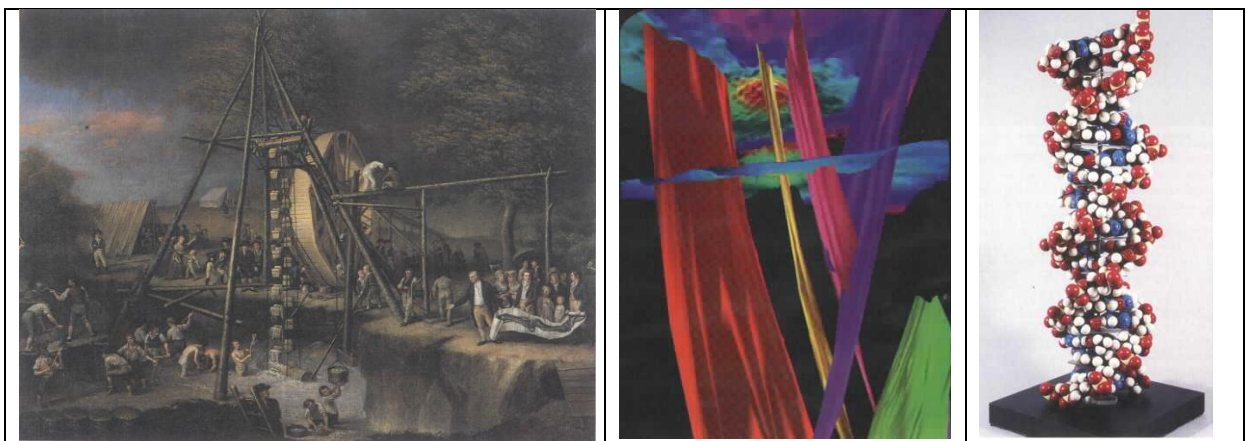


Figure 6: Many different ways in which art works for the sake of better science. a- “The exhumation of the mastodon”, by C. Willson Peale. b- Graphical display of seismic information about the geology of subsoil (From Shirley, 1998) c- A 3D model of DNA.



### *Science in the service of Art*

The development of geometrical rules to represent the three dimensions of space on a two dimensional surface may be regarded as one of the most impressive contributions of Science to the Art, but is just one in a bunch of them. On the one hand, theories about proportions, symmetry, tessellation and most recently geometrical art, fractals and digital design, pave the road of Art. On the other hand deep studies in anatomy help drawers like Da Vinci or Rembrand represent the human body. What about instruments and the recording and reproduction of music without the help of technology? What about performing arts without the aid of modern technologies of light and sound? Figure 7 illustrates the collaborative work of an sculptor and a man of science, in this case Velázquez and Martínez Montañés produced images of the King for the sculptor P. Tacca, who designed the monument after the wise advise of Galileo Galilei, who helped finding the way for the horse, resting only on its rare legs, not to split in two pieces.

But the collaboration of Science to help Art goes still further, scientists helping not only artists but museums, historians, etc. finding the composition of ancient pigments, dating ceramics or establishing the quarry of origin of the stone of a sculpture and allowing detection of fakes. The progress in this interaction art-science-technology can clearly be illustrated by the example of the impressive images in <http://www.universalleonardo.org/>



Figure 7: The calculations for this equestrian sculpture not to fall after the yield of the rare legs of the horse are attributed to Galileo. The sculpture of Felipe IV of Spain was designed by Pietro Tacca after a painting by D. Velázquez and a bust of the king by Martínez Montañés (photography by the author).

### *Art and Science in the service of Society*

Scientists and Artist have many times joined their voices in order to awake or aware society from present and future problems that need immediate attention. The cases of the Ozone Hole or the Global Warming at present times have fostered this kind of participation, but there are examples coming from the past as the scene illustrated in Figure 8, presenting in a compelling manner the problem of soil destruction produced by wrong farming techniques during periods of lasting droughts.

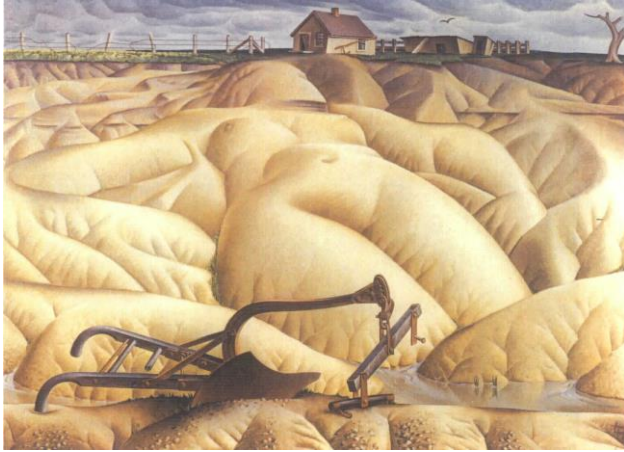


Figure 8: “Erosion N° 2, Mother Earth laid bared”, by Alexandre Hogue, was inspired by the destruction of the soil caused by the use of intensive and inappropriate cultivation techniques in the United States in the dry 1930’s (Philbrook Art Center, Tulsa).

## Conclusions

Artists and scientists share abilities and skills to see, describe, make interpretations and communicate, but their interpretations differ in their objectives and are, therefore, different and not interchangeable. Repetitiveness of a measure resulting from an experiment or from the observation of nature is a keystone in science; originality for itself, without demonstration of truth and applicability is nothing for scientific understanding. Being one and only among many has been essential to every work of art along many centuries and this leads the artist in his search to find a language that, although understandable, could be recognized as personal. Both of them require freedom to express and show what they have finally come out with. Both usually have troubles with the “establishment”. The idea of geologic time (not to mention evolution) was regarded as dangerous or immoral as an impressionist nude at the time they were initially proposed.

It can be agreed that artists and scientist share curiosity, the passion for searching and finding what has not yet been discovered and explored but taking in account that most of the time actual “discovery” consists not in the finding of the unknown but in the observation of the already known with new eyes (what actually means with new ideas behind them).

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