# Visual language in techno-science and policy: evidence and metaphor

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Presented @ Science and Democracy Network Annual Meeting 2007

Centre for Research in the Arts, Social Sciences and Humanities (CRASSH)
University of Cambridge, UK
June 27-29, 2007

## Introduction

Science imagery is under a deep transition. New technologies such as low cost powerful imaging software and the worldwide web critically contribute in assigning a central role to visual language in science, in speeding up the paste at which scientific images have to be produced, and, consequently, in fostering a hybridization of knowledge and expertise.
Digital information can be modified indefinitely and in a reversible way. At the same time, it can be shared in real time with distant and arbitrary communities of users.
As a result, more science is available on line to common citizens and the borderline between specialized scientific images, visual evidences for a restricted community of peers, and pictures for the general public, elaborated products of visual design conceived not only to educate but also to persuade, is more and more subtle.
Scientists are encouraged and trained to produce images that work for submissions to professional journals as well as for citizens at large, therefore occupying the territory of science communication. At the same time, image-makers of various sort, going from image-processing amateurs, to image designers, all the way to visual artists and common citizens, have a growing role in creating the contemporary techno-scientific visual discourse.
The aim of this work is to illustrate with a few examples some of the issues arising from this complex shift in the conception and use of science images and to stimulate a reflection about its implications.

## The risk and marvel manipulated evidences

1. On Friday 14 January 2005, the European Space Agency's (ESA) probe Huygens landed on Titan, Saturn's largest moon. The first set of raw data coming from the distant planet were uploaded on the ESA server and were made accessible to the public by mistake, before the scientists had a chance to make any analysis. A group of space-images enthusiasts, who was eagerly waiting for the first release, immediately started to elaborate the mosaic of digital information, 350 low resolution black and white triplet images made by three different cameras at different angles and magnifications [fig.1]. Within a few hours, a set of elaborated color landscapes created with standard image manipulation software such as Photoshop and Terragen, was made available on line. A cautious warning was posted: the embellishments were not necessarily accurate but they were meant to be enjoyed for what they represented. On Saturday 15 January, Anthony

Liekens, one of the authors and a doctoral student in biomedical imaging at the University of Eindhoven in the Netherland, tuned into the ESA press conference and was disappointed by the quality of their images. He decided to create a virtual gallery on his website to host amateur renderings of Titan's landscape, such as the stunning color images made by Mike Zawistowski, a freelance computer-repair expert based in Boston [fig. 2,3]. The images slowly filtered across cyberspace all the way to the media giants such as CNN and BBC. How did scientists react? Bewilderment at first, followed by great interest in creating future collaborations with amateurs of this sort. Indeed, the unintended experiment ended up as being a public relation success. "Their beauty was not matched by the images we released." stated Jean-Pierre Lebreton, the ESA Huygens project manager.

This episode, which was reported in various scientific literature [1,2] raises some interesting issues concerning the nature of scientific imagery our culture. Three specific attributes of the images made the case: their beauty, the speed of their release, the fact that they were made by amateurs. Let's consider the way they relate to each other. The issue of beauty in science is far from being new. In the modern paradigm, science is generally thought of as being concerned with truth, and beauty is considered as an attribute this latter. But the kind of beauty we deal with in this case is closer to a concrete and relative quality, what we call "appeal" or "attractiveness", than to an abstract and absolute ideal. The raw data coming through deep space from a distant planet carry a measurable set of factual information, the scientific core of the mission, together with a load of emotional content, metaphors having to do with the marvel of human inventiveness and of its capacity to endlessly explore and control the realm of natural phenomena; That is, metaphors based on a set of values that altogether determine a specific conception of technoscientific research. The former aspect of the images is the one that should justify the research and the mission altogether, but it is the latter that raises public interest and therefore swings political decisions to increase or cut the funding.

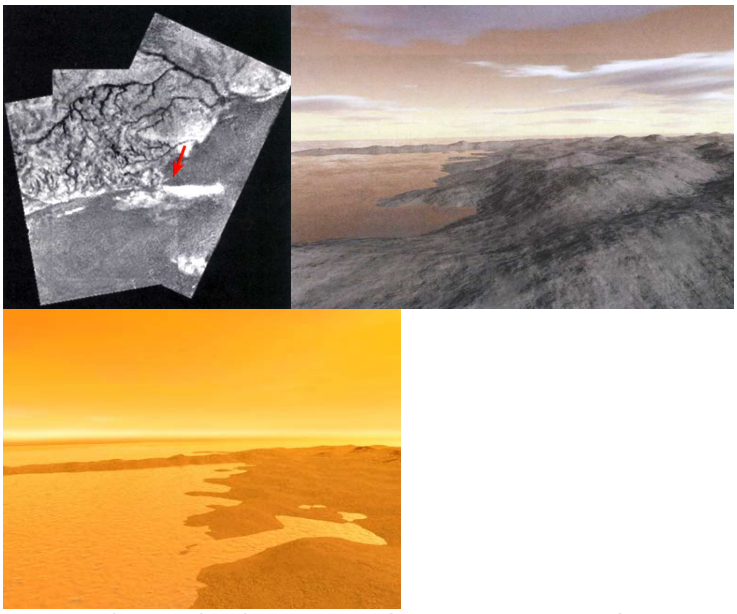
In this scenario, the process of creating the final images is indeed very delicate: scientists can't limit their focus to the purely informational content: they have to mediate between scientific accuracy and esthetic concerns, in order to catch the public attention. Behind all this, is the assumption that the same images, shared on the web, have to work both within and outside of the community of peers.

As reported in the *San Francisco Chronicle* in an article regarding the ESA mission:

> … Modern space missions all seem to end the same way: with indistinct pictures of orange rocks, followed by impassioned hyperbole from scientist types attempting to convince us how totally awesome the images are.

Indeed, scientists' expertise not necessarily entails the capacity to create visually compelling products for the public; and to make them in a constantly shrinking time-frame, determined by the accelerating paste of digital mass media. A different kind of expertise is evidently needed to fill this gap, leading to the following situation: "Professional space-scientists/amateurs image designers" eagerly look for "professional image designers/amateurs space-scientists" for long term and fruitful collaborations.

The aura of epistemic privilege that used to characterize the modern model of a self - sufficient community of science fades away in this post-modern co-production of knowledge and expertise.



1.© ESA/NASA /JPL/University of Arizona. 2. © Mike Zawistowski/ESA/NASA/JPL/University of Arizona. 3. © Mike Zawistowski/ESA/NASA/JPL/University of Arizona.

2. In April 2005, *Nature* [3] publishes an article about image manipulation in cell and molecular biology. The issue a stake is the difficulty and the need to establish a clear boundary that divides useful and legitimate visual enhancement of experimental evidences from misrepresentation of results and therefore scientific misconduct.

The widespread diffusion of digital photography and manipulation software, create a new scenario in which scientists have at their disposal a set of powerful tools to modify at ease - indefinitely and reversibly, their raw data, without having to repeat the actual experiment.

As reported in the article, in 1989−90, only 2.5% of allegations examined by the US Office of Research Integrity, which monitors misconduct in biomedical research, involved contested scientific images. By 2001, this figure had jumped to nearly 26%.

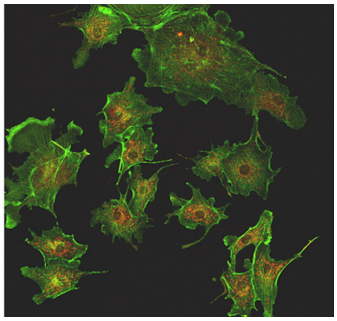
Still, in most cases the alterations end up as being products of ingenuity, attributable to a lack of expertise in dealing critically with the sophisticated and constantly evolving equipment involved. Indeed, a growing number of digital adjustment options, such as exposure settings on microscopes or digital cameras, are available even before recording the experimental information and scientists tend to consider these kinds of operations as unproblematic. Moreover, once the data are acquired, researchers typically operate on the digital information by using the basic adjustments of their image-processing software. Due to a lack of extensive knowledge in its use, the software design itself plays therefore a role in the final look of the images.

Pressure as well is an important factor in the process: the highly competitive environment in which molecular and cell biologists work don't allow for second thoughts or provisional results [4]. Digital polishing or clean up is a much faster way to generate a presentation-quality image than remaking the actual experiment; and a clean, faultless picture is an encouraging message for reviewers and editors[1]. It seems then difficult not to succumb, even innocently, to the temptation of using all of the possible devices in

[1] Eliminating visual ambiguity doesn't leave room for unexpected developments: what is considered as digital noise from a research group that is focusing on a given set of phenomena could be in fact relevant scientific information for other researchers.

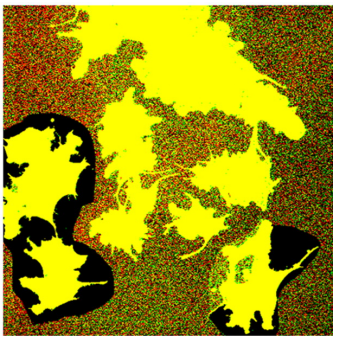
order to make the result more evident, readable, accessible and finally attractive. All this, quite often, to the detriment of scientific accuracy.
The proposed strategies to face this problem tend to focus on measures *ex post* such as the introduction of forensics procedure to patrol the practice of image manipulation [Fig. 4a-4b] associated with the elaboration of specific guidelines for image submissions in scientific journals [5], and a small emphasis is given to measures *ex ante* such the institution of postgraduate courses on the ethics of digital imaging. All of these efforts seem to denote a difficulty within the science community in preserving its system of internal legitimation of knowledge and a determined attempt to maintain it. There seems to be little room for a more radical discussion about the evolving role of visual language in science and of the emergence of a new kind of imagery that requires a mixing of expertise and implies a growing tension between factual and metaphorical content.

Manipulated image



4a. © The Rockefeller University Press

Manipulation revealed by contrast adjustment



4b © The Rockefeller University Press

3. In March 2002, Felice Frankel, science photographer and research scientist in the School of Science at MIT, publishes a book called *Envisioning science: the design and craft of science images* [6]. Interestingly enough, her big and colorful volume with a captivating title is not addressed to the general public, but to the science community; it is in fact presented as a technical manual, to keep in the lab, to improve the quality of scientific images for journal submissions, for funding agencies, investors and for the general public. The work is the result of a few years of intensive in-the-field collaboration with scientists and engineers for creating more accessible, compelling and beautiful science pictures. When looking more closely at her professional profile, we find out that she is behind many cover pictures of the most credited scientific journals such as *Science* and *Nature*, that she regularly writes a column in the magazine *American Scientist* about science images and that her pictures are shown as artwork in science museums around the world [Fig.5,6]. Being a visual science-designer/visual artist/image design educator, she clearly embodies the cultural transition now occurring not only in the science visual discourse, but also in the technoscientific culture in general.

As we read in her introduction:

> This book is about a new kind of science image, an image that communicates your work more effectively to both colleagues and the general public.
>
> The science pictures you see here have an additional purpose to those in your notebooks. Although often used for presentations

> and submissions to the professionals, they also communicate science to the general public and thus capture the attention of those unfamiliar with the subject. They have a component that is sometimes called 'artful' a word, I, like you should be wary of using. They might appear as personal interpretations but they are not. They are honest documentations of scientific investigations. However, they have an additional quality not usually present in science image – they somehow include the marvel of whatever phenomena I intend to capture.

In these few lines, we deal with many of the issues encountered so far. The idea that visual evidences have not only to represent experimental results, but also to effectively communicate them, both within and outside the science community, is formalized with the introduction of a "new kind of image". The issue of beauty is explicitly brought up and the tension between subjective interpretation and objective documentation is resolved as being only apparent. Finally, the emotional content of the images, "marvel" is openly mentioned as an "additional quality".

Let's briefly discuss her claims. The explicit recognition that the purpose of science images has to be extended to outside of the community of peers seems to work in the direction of a democratization of science and indeed we read in what follows:

> Using compelling and accessible pictures is a powerful way to draw the public's interest to the world of research. When the public develops a more intimate association with science the results will be both a richer society and one supporting the important efforts in scientific investigation.

But what model of scientific investigation is communicated through the images? What kind of scientific research is supported? We could find an answer to this question in reconsidering the additional quality of the images: the marvel of an honest documentation of natural phenomena for what they are. In this perspective, scientists should learn to embrace and utilize new technologies in all their potentials in order to show the scientific truths they discover, in all their intrinsic beauty.
The model of science that seems to be implied by the metaphors conveyed by the "marvel" of the images is again the modern ideal of a privileged and certain knowledge, the result of an objective investigation of natural phenomena in which the axiological dimension can be excluded. There seems again to be little room for an open discussion about the model itself, and these new conceptual and technological tools are essentially utilized for its preservation, as marketing devices[2].

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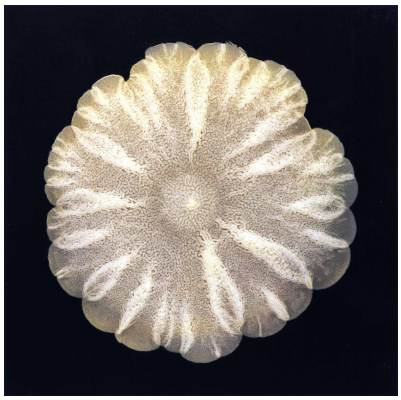
[2] Similar considerations could be made about the related phenomenon of the growing number of scientific visualization competitions, instituted and promoted both in the public (such as the National Science Foundation) and the private sectors (such as Novartis) of technoscientific research [Fig 7]. As an example, we read in *Science* (Vol. 309, **5743**, p. 1989 (2005)):

> Some of science's most powerful statements are not made in words. From the diagrams of DaVinci to Hooke's microscopic bestiary, the beaks of Darwin's finches, Rosalind Franklin's x-rays, or the latest photographic marvels retrieved from the remotest galactic outback, visualization of research has a long and literally illustrious history. To illustrate is, etymologically and actually, to enlighten.

5. © Felice Frankel



6. © Felice Frankel

7. © Cheryl Aaron, Omega Optical, Inc., Brattleboro, Vermont

## Evidences of complexity

1. By the end of 1999, Gary Braash, an environmental photographer who for twenty-five years had reported on natural history in many parts of the world, began to travel around the world in search for physical evidences of climate change. In his ongoing project of documentation, the *World View of Global Warming* [7], the photographer strictly collaborates with an extensive number of scientists with different backgrounds, in the different areas of the planet. His images range from matter-of-fact repetitions of historical glacier photographs to portraits of scientists at work and of people whose life is already affected if not compromised by climate change [Fig.8,9,10].

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The National Science Foundation (NSF) and *Science* created the Science and Engineering Visualization Challenge to celebrate that grand tradition-and to encourage its continued growth. In a world where science literacy is dismayingly rare, illustrations provide the most immediate and influential connection between scientists and other citizens, and the best hope for nurturing popular interest. Indeed, they are now a necessity for public understanding of research developments: In an increasingly graphics-oriented culture, where people acquire the majority of their news from TV and the World Wide Web, a story without a vivid and intriguing image is often no story at all.

2. In March 2004, the environmental journalist Mark Lynas, published *High Tide* [9], a record of its three years long travel around the globe to tell a story about climate change through his personal experience and the one of the ordinary individuals he encountered. Stories go from the only remaining resident of a remote village in Northern China abandoned because of drought, to the Qollyur Rit'i festival in Peruvian Andes where indigenous people celebrate the 'apu' gods who live in the glaciers. A visual diary is an integral part of the text [Fig.11,12].
3. In 2003, the visual artist David Buckland, conceived and realized the first Cape Farewell expedition [10], a sailing travel into the High Artic Ocean, trough a route that was previously icebound but is now passable. Scientists, education policy writers and renowned artists were invited on board to explore the encountered environment, the delicate polar oceanic ecosystem, with their approach and language. Artistic experiences and inspirations were literally going hand in hand with scientific experiments and enquiries. In this ongoing project, now at its 4th expedition, a vast artistic, scientific and educational documentation is collected and then elaborated and presented in various institutions such as universities and museums[3] [Fig 13, 14].
4. Since 2005, BBC News [11] asks its website readers to send images with a comment on how environmental changes are effecting their lives.

These examples show how visual language can be used within the scientific framework of a socio-environmental controversial issue such as the one of global climate change. One more time, we deal with beauty, with scientific accuracy -or significance, with a tension between factual and emotional content, and with a hybridization of knowledge and expertise, but in a radically innovative way. Indeed, in dealing with the issue of climate change in all its complexity, the specific, subjective perspective a photographer, a writer, a visual artist, a common citizen is taken to be as relevant as the abstract quantitative approach of a scientist. Different kinds of knowledge and expertise are truly combined in order to create a more adequate vision of the problem, one in which facts and values can't and shouldn't be thought of as separated. Finally, in this approach the modern ideal of science as holding a privileged kind of knowledge is actually abandoned in favor of a genuine post-modern –or, more precisely, a post-normal paradigm [12].

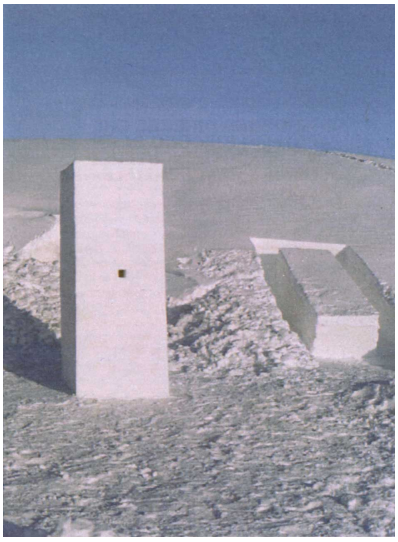

8. © Gary Braaash


9. © Gary Braash

[3] The exhibition and book *Burning Ice: the art of climate change* is currently on view at the National History Museum in London.


10. © Gary Braash

11, 12. © Mark Lynas



13. © Peter Clegg

14. © Dan Harvey

## Conclusions

The aim of this brief overview is to stimulate a discussion about the conception and use of visual language in the contemporary technoscientific culture, and about its possible implications in a process of democratization of science.
The idea of scientists directly communicating with the public and of the mixing of different kinds of competences and cultural backgrounds in creating new kinds of images

induce to think about a greater level of awareness and participation of the society in the techno-scientific research. But an actual step in this direction can only be made if the final products of this complex process of post-modern co-production of knowledge and expertise are conceived, presented and used in order to critically discuss and redefine the modern ideal of techno-scientific research. All images, including science images, inevitably convey values together with facts. This intrinsic complexity can be used to maintain the modern program of 'science speaking truth to power' (and 'power' speaking truth to citizens), but it can also become a valuable democratic instrument when the axiological dimension is not concealed, but openly revealed and discussed.

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