

The Epistemic Functions of Vision in Science October 2018, 10th – 12th

Università degli Studi di Bergamo Max Planck Institute for the History of Science, Berlin



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Rationale

The Epistemic Functions of Vision in Science

We want to explore continuity and ruptures in the historical use of images in science, while also considering more recent developments which attest for an unprecedented importance of visualizations in science, be these video recordings, animations, simulations, graphs, or enhanced reality.

The function of visual material is defined according to three major epistemic categories: exploration, transformation, and transmission of knowledge.

As a means of exploration, the process of visualizing has been used in the context of scientific discovery. Visualizations allow to develop new research perspectives and ideas, especially in the framework of modern science, as this is characterized by a strong mathematical approach.

Visualization, moreover, has also been a means to transform and re-shape knowledge. It allows the adaption of knowledge to our methodological, institutional, and, generally, cultural expectations, and enables the integration of practical and tacit knowledge.

Finally, visual material is the preferred means for the transmission of knowledge due to its highly synthetic character and the apparent ease with which knowledge is perceived and re-worked by its recipients. The Visual codification of knowledge can therefore be seen as a historical phenomenon that emerged in consequence of an increase in knowledge resources, of processes of knowledge accumulation, and of the demand for scientific knowledge. The use of visual material in science always had the effect of lowering the threshold toward the access to knowledge and therefore became a preferred means for education.

Such epistemic functions of visual scientific material, moreover, are analyzed in their cultural, social and technological context. The historical actors' opinions and judgements concerning the use of visual material and technological innovations in the media of knowledge transmission—be these clay, paper, or processors—influenced and were influenced by the process of visual codification of scientific knowledge. By considering the epistemic functions and their interplay with the material aspects, case studies are collected that show the functions of such visual material in the science of the past, ideally from antiquity until now and ranging through all possible cultures.

Organization and Directions

Venue

University of Bergamo Sant'Agostino - Aula 1 Walter Fornasa Piazzale S. Agostino, 2 Bergamo Hotel

Hotel Excelsior S. Marco Piazzale Repubblica, 6 24122 Bergamo

https://www.hotelsanmarco.com/en/

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Abstracts

Opening Lecture: The Mediatory Role of Images Jürgen Renn

The talk discusses the role of images as mediatory instances in the knowledge economy of a society. Both knowledge and institutions involve external representations which are critical for their reproduction and development, but also for framing themselves and other communities. The societal production, reproduction, and appropriation of knowledge in an ensemble of institutions constitutes the "knowledge economy" of a society. At the interfaces of different knowledge economies, representations inevitably become ambiguous or may assume new mediatory or conflicting meanings. Images play an important mediatory role between science and its cultural context. The study of images makes it evident that scientific knowledge has a deeper, more complex structure than is apparent if one only focuses on texts. They mediate not only between science and its cultural context, but also between practical knowledge and its theoretical reflection in scientific theories.

This mediatory role cannot be captured by the traditional aporias of the concept of representation, suggesting that it is either the exertion of power or the faithful imaging of reality. By deconstructing the act of representation as an act of the unescapable execution of power, post-structuralist writers pretend to undo colonial violence, but they actually risk to erase the symptoms which the unresolved conflicts of the past may have left us. The talk argues instead for the need of a non-reductive theoretical language to do justice to the role of images in knowledge generation, stabilization, and circulation.

1. Theorizing Technology: *Theoria*, Diagram, and Artifact in Hero of Alexandria Courtney Ann Roby

This paper will examine the interplay in Hero of Alexandria's *Dioptra*, *Automata*, *Belopoeica*, and *Pneumatica* between "diagrammatic" and "theoretical" ways of subjecting technological artifacts to forms of visual discipline. *Theoria* and its cognates appear throughout Hero of Alexandria's works to reflect a set of disciplined observational activities that interrogate the links between text and artifact, the boundaries between nature and the artificial structures (including texts) that mediate our experience of it, and the limits of our abilities to observe and describe the world around us. The objects observed include natural phenomena and artificial devices, as well as the diagrams in Hero's own texts and the logical structures that underlie the systematic frameworks of his works.

For Hero, *theoria* may indicate an act of observation in the world, often disciplined with a specialized instrument; a way of seeing *through* diagrams and instruments to physical phenomena that are normally invisible; or a conceptual structure such as underlies Euclid's *Elements*. He sometimes uses the term *theorema*

to mean a "spectacle" of the kind afforded by his pneumatic wonders and automaton theaters; sometimes it indicates a diagram where an artifact or process can be experienced visually in the text itself; sometimes it is rather the design or form underlying the artifact's structure; and sometimes it suggests instead the conceptual structures that help the reader learn from his texts.

Hero's ability to make this multiform "theorizing" work in his texts depends very strongly on his extensive use of diagrams including depictions of artifacts in construction, completed structures, and processes for observations with the surveying instrument known as the dioptra. Certain attributes of the artifacts he describes, like the materials of which it is composed, the names and sizes of its components, claims and proofs about how its components function, are typically expressed verbally rather than visually. Others, like the combination of multiple components into a complex structure or a geometrical analogue for a precisely-shaped component, seem for Hero to demand visual representation.

The diagram provides a site where those attributes can be experienced with the immediacy of a visual encounter, which can reinforce, supplement, or even challenge the verbal text. Diagrams also mediate between the abstract geometrical objects that allow Hero to perform the measurements and proofs his texts require and the material world where those measurements and proofs come to fruition. Indeed, they serve as a kind of model space where the rules of geometry can be transferred to a space where they cannot usually be assumed to operate. Likewise, though Hero's *theōria* certainly embraces a wide range of ways of seeing, they cluster semantically around their ability to link domains – the abstract and the concrete, the mathematical and the material, objects in the world and diagrams in the text – while preserving the truth value of observations as they move between domains.

2. Vision on Vision: Early Modern Scientific Images on Cosmology Explored by Means of Second Order Images

Matteo Valleriani, Florian Kräutli

The paper approaches the subject of visualization in science from two perspectives: on one hand it describes a specific historical tradition for the use of scientific images in cosmology teaching (Transmission) during the early modern period, both in its general development and by considering specific cases; on the other hand it shows how specific contemporary techniques of visualization, developed in the frame of digital humanities, allow to investigate large historical corpora (Exploration) both on the macro and micro level.

The historical images under scrutiny are mostly scientific diagrams that were printed in treatises on cosmology which followed the tradition of the 13th century *De sphaera* by Johannes de Sacrobosco. The treatises were qualitative introductions to geocentric cosmology and were used as mandatory textbooks in quadrivial teaching at Faculties of Liberal Arts. The paper will focus in particular on the first 100 years of this edition history and consider 209 different editions printed all over Europe from 1472 to 1571, resulting in a total amount of roughly 7000 images.

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The determination of general trends in the development of visual material in early modern science, as well as the clarification of exact scientific content through a text-image analysis on selected cases are the final results of this historical research.

Methods of digital visualization are employed to conduct a "distant reading" of the entire collection of images. A precondition is the identification of identical or similar images across the corpus. This identification is achieved through a combination of automatic image recognition and manual error correction. The subsequent analysis is performed by visualizing the resulting classification in relation to relevant dimensions derived from the metadata of the textbooks: dates of publication, placement within a book, printers and publishers of the books, etc. This approach requires the underlying mechanisms of the image recognition algorithm to be understood, and the manual adjustments – which may be based on deduction, interpretation, or prior knowledge – to be made explicit. The paper will look at the possible findings this method enables, while also scrutinizing the method itself.

3. The Illustrated Printed Page as a Tool for Thinking and Transmitting Knowledge. The Case of Renaissance Astronomical Books

Isabelle Pantin

During the early modern period, astronomy underwent a profound transformation, not only in its methods, aims, and theoretical developments and prospects, but also in the way it was taught, and even popularized: the response of an enlarged readership to the works of astronomers gained more and more importance. All these changes were mirrored (and sometimes accelerated) by the evolution of the books' lay-out, notably concerning their use of images and geometrical diagrams.

I shall examine and compare different kinds of astronomical books (from elementary manuals to books for specialists) with regard to this evolution, in order to discover to what extent the reading field constituted by the printed page (or rather the double page of the open book) was used as an instrument for learning and understanding. Among the examined features are the emergence and improvement of the lettering and legends of diagrams, the way the relationship between the images and the surrounding text was conceived, and the use of images as concrete metaphors of abstract concepts.

The hypothesis I shall put to the test is that such innovations were often first introduced in books intended for students—either mere beginners or those who were moderately advanced (like the readers of the *Theoricae planetarum*)—and were afterwards either progressively transmitted to other categories of books, or used for higher intellectual goals: so, for instance, in the *Epitome astronomiae copernicanae*, where Kepler illustrated his new theory of the physical causes of planetary motions with images of a kind normally found in elementary textbooks.

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4. No pueden la pintura de mi pluma y palabras dar tan particular razón [...] sin el pincel o debujo, y aun con esto serían menester los colores. Images and Artifacts in the Invention of the Americas

Elena Paulino Montero

When in the first decades of the XVI century Fernández de Oviedo was describing the fruit of the pineapple that he had saw (and tasted) in the Caribbean for the first time, he overtly expressed his frustration over his inability to capture and transmit the whole complexity of the new plants, animals, landscapes and peoples of the New World. He declared the insufficiency of both words and images, either by themselves or in combination, and in his *Historia Natural de las Indias* he explored the limits of the verbal and visual representation in his practice as chronicler and historian. Almost one century later, the traveler and missionary Jean de Lery, who lived for several months among the Tupinamba in Brazil, encountered similar problems, stating that their gestures and expressions were so different that was almost impossible to represent them either with words or images.

Although during the XVI century artists and scientists were increasingly comfortable with the idea that abstract concepts and the activity of the mind could be represented by images and emblems, the discovery of new territories, people and landscapes brought new problems of representation, associated with accuracy, understandability and (un)translatability.

In this paper I will explore the role of the images in the European *inventio* (as both "discovery" and "creation") of the Americas in the first decades after the arrival of Columbus to the island of La Hispaniola. I will argue that the transmission of new knowledge at the beginning of the XVI century followed many different strategies and explored different media, although this multimediality has traditionally been fragmented by disciplinary boundaries, and the relation between literary and visual traditions and genre conventions still needs to be analyzed in depth. Illustrations for new texts were perceived as a crucial need since the publication of the 1493 letter of Columbus, but also the objects themselves, coming from the Americas and collected in the main European courts, played a key role in the visualization and recreation of a new reality that was difficult to represent and understand. In a third group, maps were not only necessary to transmit geographical and cartographical information but were also used in the construction of an image of the New World increasingly associated with consumption and commodification of natural resources and people that would be completed and refined during the next centuries.

5. Artistic "Libido" and Scientific Truth in 16th Century Woodcut Illustrations Magdalena Bushart

In his introduction to the "Historia Stirpium" (1542), the botanist Leonhart Fuchs claimed that the images of this herbal did not follow the whims of the art, but solely picture the truth: "De industria vero et data opera cavimus ne umbris, alijsque minus necessarjs, quibus interdum artis gloriam affectant pictores, nativa

herbarum forma obliteraretur; neque passi sumus ut sic libidini suae indulgerent artifices, ut minus subinde veritati pictura respondet." What, according to the author, seemed a victory of science over art, must have felt a defeat to the artists who had created the book's woodcuts. After all, being specialists in the production of prints they defined their standards over a highly refined artistic vocabulary, a complex visual network, and a flourishing market of printed images. In my paper I will deal with the question of visual codifications of knowledge with regards to the artistic codes inscribed in the visual culture of that time, focusing on three famous books: Otto Brunfels', Contrafayt Kreüterbuch" (1537), "Des Menschen Beschreibung oder Anatomie" by Walther Hermann Ryff (1541) and "Historia Stirpium" by Fuchs: How is the intersection of aisthetis and episteme being defined in herbals and in anatomy books from the first half of the 16th century? What specific qualities are necessary in order to convey knowledge? How do scientific pictures compare to the conventions of representation of the time? What kind of compromises do artists like Hans Baldung Grien, Hans Wechtlich, Hans Weiditz, Heinrich Füllmaurer have to make illustrating scientific books? How do they deal with the conditions of a publishing sector that asks for variations of successfully established patterns, rather than for new pictures? Where do differences between the argumentation of the text and the information of the illustrations arise, where is a failure of the transfer of knowledge unavoidable?

Visual Culture of University Knowledge: The Lecture Notebooks from Louvain and Douai (17th-18th centuries)

Gwendoline de Mûelenaere

In the universities of the early modern Southern Netherlands (Louvain and Douai), images were abundantly used for didactic, but also socio-political and symbolic purposes. The surviving handwritten lecture notes range from 1601 to the end of the 18th century. They result from the education provided by the Faculty of Arts, in which students were taught logic, physics, metaphysics, and ethics. These fields could be completed by the study of mathematical disciplines such as geometry, arithmetic, astronomy, optics, statics, music, military architecture, etc.

In those notebooks, the text is often accompanied by title pages, drawings and engravings. Two kinds of images coexist in a single space: a scientific imagery made of abstract forms and aiming at fostering the understanding of the subject (geometrical patterns, diagrams, tree structures, legends), and an iconography inspired by non-scientific figurative languages, of allegorical, emblematic, descriptive, religious, historical, mythological, moral or satirical nature. Erudition is not only depicted, but also staged and celebrated. This celebration of knowledge through the embellishment of lecture notebooks denotes symbolic stakes.

The paper I propose will focus on the role of the image in the transmission of knowledge within the framework of higher education institutions in the Southern Low Countries. This study of a selection of illustrated notebooks will be articulated around two main issues. Firstly, what are the rhetorical and visual strategies used in such representations to convey new scientific ideas, or on the contrary, old ways of thinking? How were Western traditions of allegory, emblematics and symbolics employed, adapted to the academic message, and, possibly, combined with a mathematical vocabulary, emerging at the time? In this regard, comparisons will be made with thesis prints produced in the same academic environment. And secondly, what can we discover about the learning mechanisms used by the students (for instance the mnemonic function of the illustrations which visually structured the notebook)?

7. Representing Experience in the Early Royal Society. The Case of Robert Hooke's *Micrographia* (1665)

Salvatore Ricciardo

My contribution focuses on the graphic project Robert Hooke (1635-1703) developed for the Royal Society in the mid-1660s, which resulted in his celebrated *Micrographia*, the illustrated volume of his microscopic investigations published at London in 1665. As a corporate body, the early Royal Society aimed at promoting experimental knowledge as the most effective means of attaining the reform of natural philosophy envisaged by Francis Bacon in the early decades of the century. Such an enterprise involved testing previous assertions on the natural world; integrating new technologies and collaborative efforts to produce new knowledge; the transmission of new findings by launching publishing initiatives. Hooke's *Micrographia* stands out as the most notable example of the early Royal Society's reformist project, notably for the role played by visual demonstration in divulging the new world unveiled by the microscope. The printed images of magnified objects and insects were aimed at filling the gap between the naked senses and what the eye can see through the microscopic lenses. Therefore, they played a crucial role in making visible what Hooke called the 'true form' of natural bodies.

I will argue that *Micrographia* provides us with new insights into the explorative and didactic functions of printed images in the early modern period. First, I will deal with the cultural and historical context surrounding the origins of the book in early Restoration London, highlighting the role played by instruments makers and Fellows who provided a collective check on the accuracy of Hooke's representations and conclusions. Hooke's long preface and his descriptions annexed to the plates, especially the representation of a drone fly's head and eyes, will form the subject of the second part. It will be my contention that such visual and textual material teaches us how images were the outcome of a complex process that involved scrutinizing and synthesizing perception. I will dwell upon technical and observational issues involved in Hooke's microscopic investigation, comparing his conclusions about the drone fly's eye with the description of the same insect delivered by the Halifax physician Henry Power in his *Experimental Philosophy* (London, 1664), the other substantial contribution to English microscopy of this period. Drawing as the final stage of the observational process will be the subject of the third and last part of my contribution. Hooke's clear demarcation between observation and graphic transposition implies that printed images embodied a series of diachronic visual acts, then projected in

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drawings by means of inferences from sensory perceptions. As a result, illustrations might not be, in all cases, faithful representations of the object seen under microscope, as Hooke himself recognized.

8. Capturing, Modeling, Overviewing and Making Credible: The Functions of Visual at the Accademia del Cimento

Giulia Giannini

The Accademia del Cimento in Florence is the first European society to put experimentation at the core of scientific activity and to be supported by a public power. During the ten years of its activity, the Cimento carried out hundreds of experiments. A minor part of them is collected in the only printed work produced by the Accademia, the *Saggi di Naturali Esperienze* (1667). Almost one hundred illustrations accompany the 12 groups of experiments presented in the *Saggi*. These are mainly drawings of instruments and experimental apparatus. In spite of the sumptuousness of the edition, these drawings are not deeply realistic rendering of the experiments like in the famous Boyle's air-pump engraving. They often are simplified abstractions showing the apparatus internal working.

Tables, diagrams and illustrations also punctuate diaries, handwritten notes and correspondence. The presence of visual material in these 'unofficial' reports cannot be merely attribute to the desire of making the experiments more credible. Indeed, a study of the unpublished documents shows the role of visual images in experimental design and allows to explore the wider problem of the relationship between thought and vision. In this contribution, I will analyse the epistemic function of visual in the Cimento's experiments and debates around the issue of natural freezing and the properties of heat and cold.

The academicians performed a multitude of experiments on the nature of heat and cold, on the existence of "frigorific" atoms and they advanced different hypotheses to explain the process of natural freezing. The expansion of volume that takes place when water turns into ice questioned the Platonic theory (supported by Galileo and strongly opposed by all atomists, from Democritus to Gassendi) according to which cold is the mere absence of heat. In order to justify this phenomenon and salvage the idea of cold as deprivation, many experiments and hypothesis were put forward. Prince Leopoldo was very involved in this debate: not only did he urge his fellow academicians to work on this problem, but he himself put forward experiments, including some ingenious ones. For example, he chilled an empty carafe with a long, fragile neck by putting it in ice, and then he turned it upside down into a bowl filled with water. After breaking the neck of the carafe he observed that the water entered the carafe without encountering any oppositions. On the other hand, by heating up a similar carafe and repeating the same experiment, not only did the water not enter the carafe, but one could visibly observe something resembling a waft coming out from the mouth of the carafe. This experiment seemed to visually demonstrate the corporeity of heat and the privative nature of cold. Discussions on the topic include geometrical demonstrations and mathematical representations, punctually excluded from the *Saaqai* but occasionally resumed by individual members in later works.

9. Marcello Malpighi and His Observations of the Chick in the Egg

Sietske Fransen

Since Aristotle the development of a chick in an egg was used to observe the generation of animals. In the early modern period this experiment is repeated regularly while compared with the new physiological discoveries such as the circulation of blood. Also the Italian natural philosopher Marcello Malpighi (1628-1694) repeats the experiment. However, in contrast to his predecessors he reports on his experiments not only in minute descriptions, but also in a series of drawings, visualizing all stages of the chick's development. And although his verbal descriptions do not always correspond with the observed (see Bertoloni Meli 2016, 230) it is the series of images that contain the transformative aspect of Malpighi's communication. With his drawings the reader can see the chick grow, and the comparative discussions can be dealt with on the basis of the images. In the 1670s Malpighi sent two sets of his drawings of the Chick in the Egg experiment to the Royal Society. The second series was printed by the Royal Society as "Appendix" to Malpighi's *Anatomes plantarum* (1675). In this paper, I will compare the two sets of drawings currently extant in the archives of the Royal Society in London. I will discuss how those drawings transformed further research into the generation of animals, and chicks in particular, from a verbal to a visual endeavour.

10. The Transformations of Physico-Mathematical Visual Thinking: From Descartes to Quantum Physics

Enrico Giannetto

After the Copernican revolution, it was clear that the experience of vision, due to the optical relativity of motion, could no longer be considered a reliable source of knowledge. Furtherly, new optical instruments (telescope, microscope) anyway pointed out the epistemological problem of the limits of human vision. However, the spatial-visual representation of physical phenomena operated by geometry remained a rigorous scientific practice, the source of certain conclusions. The relativization of the geometric figures made by the projective geometry of Desargues and Pascal was relevant but had no accepted consequences.

As is known, however, the algebrization of geometry operated by Descartes's analytic geometry broke the correspondence between arithmetic or algebra and its geometric intuitive meaning. The first algebraic power of any variable was no longer bound to a line, the second to a surface and the third to a volume, but the relationship between algebraic powers and geometric figures has become arbitrary. In mathematical semiotics, we passed from iconic symbols to arbitrary signs.

The geometric figuration was linked to a visual mathematical thought and the geometric representation of physical phenomena up to Galileo and Newton was based on this visual mathematical thought. The change

introduced by Descartes led to a reduction of geometry to algebraic calculus for the resolution of equations and the abandonment of visual geometric thought.

However, the analytical geometry of Descartes, on the other hand, involved a new graphical representation with respect to originally straight-line axes (not necessarily orthogonal) and thus a new geometric visualization of physico-mathematical functions.

The birth of non-Euclidean geometries led to a deeper relativization not only of geometrical representations, but more profoundly of all the visual spatial representation of physical phenomena.

With the special and general relativity theory and the four-dimensional representation of space-time there was a further problematization of visual mathematical thinking with a new abstract chrono-geometric graphic representation, linked to the externalization of the internal dimension of time.

With quantum physics and quantization of space-time, visual mathematical thinking fragments itself and requires a completely new mathematical creative imagination to understand Nature.

11. Arguing from Appearance: The Numerical Reconstruction of Galactic Tails and Bridges

Matthias Schemmel

Astronomical objects such as galaxies are known to us from the various kinds of radiation we receive from them. A large part of our information about them is contained in the spatial structures they display in optical and other frequency ranges, such as radio and gamma-ray, information that we first receive in a twodimensional projection. One of the obvious constitutive tasks of astrophysics is to find physical explanations for the shapes and spatial features of these two-dimensional images.

From the mid-twentieth century, new approaches to finding such explanations became possible through the advancement of computer technology. In particular, computer-simulations of multi-particle objects such as galaxies can be used to construct artificial images of astronomical objects whose features can then be compared to observed objects. In this way, plausible physical explanations of how they occur in nature can be found.

In my contribution, I will present historical examples of the numerical reconstruction of encounters between galaxies. Features of the numerically generated images were used to argue about the physical explanations of features displayed in the observed images. The images (obtained by observation and numerically generated) thus play a pivotal role in the physical argument. They facilitate certain arguments or make them possible in the first place. They provide a link between empirical appearance and theoretical construction.

I will show on the basis of an analysis of the discussions in respective historical publications that the images work as strong argumentative links only because they are part of an overall argument, which goes far beyond what is visible. Such overall arguments are typically based in a broad astronomical and physical knowledge, which itself is the result of a long historical process of interaction between astronomical observation and physical explanation. This knowledge base is not only employed to render the described use of images convincing in the first place, but also to assess the limits of their explanatory power.

The epistemic functions of the images in my case study are mostly in the category "exploration".

12. Visualising Biodata in the Laboratory. Image-makers, Practices and Reinvention in Magnetic Resonance Technology

Silvia Casini

How are images generated from hardware and data and signal/noise? What is and how is that scientists visualise? What do they see? My contribution to the workshop focuses on the process of visualising as exploration in the context of scientific discovery in the field of biomedical imaging and neuroscience. Visualisation is not simply an aid to science, but it is how science creates its objects, conducts its inquiries and advances its arguments. Scientific practice has always been about creating new worlds and objects or about throwing new light onto familiar things so that the way we look at them changes. Well-known examples are Leonardo da Vinci's' anatomical drawings, neural functions lighted up in colourful brain scans, Galileo Galilei's sketches of the moon surface made after his observations with the telescope, Ramon y Cajal's drawings of the neurons and further on. All these visualisations enable us to interrogate rather than simply represent the object made visible. Visualisation, therefore, works as "a question-generating machine" (Rheinberger, 1997, 32).

Through archive-based research, interviews and laboratory ethnography in the biomedical physics laboratory at the University of Aberdeen, my paper explores what and how scientists visualise when a technology is still under development and its image output and data-visualisation pipeline are not yet standardised. In this laboratory the technology of Magnetic Resonance Imaging (MRI) was reinvented in two different periods in history. The first, which occurred between the late 1960s and the early 1980s, is the period of the construction of the world's first whole-body MRI scanner for clinical purposes and the invention of the spin-warp method for transforming data into images. The second period is now, in the same biomedical physics laboratory, with the ongoing development of Fast field-cycling, MRI (FFC-MRI) a new non-invasive, low-cost biomedical imaging technique that enables the visualisation of biochemical information at a molecular level not detectable by conventional MRI.

First, I show how biomedical data-visualisation is bound to highly specific contexts and processes that are fragmented and recursive. Second, I discuss visualisation not just as a practice to make visible that which is not in sight, but much more as a vital process capable of producing new relations among things, data, spaces and people (Halpern, 2014: 21). Third, I argue that there is nothing natural and predetermined when it comes to data visualisation in the field of biomedicine and neuroscience, particularly in the case of an emerging technology, that is before the image-generating procedure and the related visual output become standardised.

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13. Nuclear Visions: Images and Epistemologies of the Planetary Crisis

Giulia Rispoli

This contribution aims to show how visual materials associated to the earth's functioning, in particular, simulations of global change and ecological processes, helped produce and systematise knowledge on the planetary crisis and the environmental predicaments generated by human intervention in the biosphere.

This paper will focus on a specific case known as the Nuclear Winter theory, popularised by the American astronomer Carl Sagan in the 1980s (Sagan, Turco: 1990). The hypothesis of an imminent nuclear winter developed with the aim of showing to the world of the intellectual, political, military and scientific elites, that a thermonuclear war between the US and the USSR, would cool down the Earth's temperature to such an extent to alter the biological processes as well as the geological components of the planet, steering it toward a new stage. This theory based on models that were the result of a collaborative effort of climatologists and mathematicians mainly from Europe, the Soviet Union and the United States, allowed many further achievements, laying the ground for the emergence of the controversial Anthropocene theory (Crutzen, Birks: 1982; Crutzen, Stoermer: 2000).

This paper displays the epistemic functions of models and simulations in fostering the rise of new disciplines such as biosphere studies and global ecology of which the nuclear winter hypothesis is a particularly important outcome. To do so, it will mainly consider categories of exploration as well transmission of knowledge, to frame the discussion on how building models turned into an occasion of knowledge sharing, leading to the coproduction of scientific evidence on the endangered planet.

${f 14.}$ Ethnosciences and the Representations of Space in the Time of Climate Change

Elena Bougleux

Strategies of adaptation and resilience to climate changes challenge the sedimented distinction between natural and cultural. Natural and cultural environments are coupled concepts (Bateson 1972, Ingold 1993), and they become fully interdependent in situations of environmental change, when the traditional environment representations become unsuitable to describe the transformed spaces. New representations of space emerge, developed at local level, which include former imaginaries superposed with new sets of information.

The entanglement between the natural and the cultural representations of space emerges more clearly during events connected to climate change, especially when these unfold as accelerated environmental crisis, caused by both predictable and unpredictable human-driven factors.

The paper discusses a few cases of changing spatial representations developed by communities which live in strict coupling with their natural environment. The paper focuses on the case study of an aboriginal community in the Territory of Northern Australia, who faces a condition of enduring coexistence with low tides and land degradation. As their interrelation with land and water is modified by the introduction of GIS technologies, a techno/visual language is being developed, able to represent their space and themselves at the same time

through visual negotiations and technical compromises. The case study is presented with the support of video samples produced by the Karrabing Film Collective (2014-2016), and it is discussed in the context of the current literature in anthropology of the environment (Dove 2015). A comparison will be made between the Australian case study and more examples of participatory environmental mapping developed in situations of environmental stress and consequent necessary adaptation processes, comprising visualizations at the cross section between technologies and traditional knowledge.

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Getting to Bergamo

<u>By Plane</u>

landing in Bergamo:

Several low-cost carriers land in Bergamo (Orio al Serio airport, <u>http://www.sacbo.it/Airpor/portalProcess.jsp?</u> <u>languageID=2</u> - sometimes advertised as Milan-Orio al Serio, or Milan-BGY); from there you can take the airport bus to the city centre (it stops just in front of your hotel, 6 stops, ca. 20 minutes), or a short taxi ride (ca. € 15-20).

landing in Milan (in which case you will then need to take a train from Milano Centrale station):

- 1. From Milano Malpensa to Milano Centrale station:
 - a. bus: Malpensa Express or Malpensa Shuttle Air Pullman (Terminal 1; the same buses also call at Terminal 2): buy tickets from the driver standing by the door of the next bus to leave; buses leave every 20 mins from 6 to midnight every day for Milan Stazione Centrale (takes 50 mins; check that it goes to Centrale not to Cadorna station). Cost: ca. € 5.
 - b. taxi: quite expensive as the airport is some way out: around € 50/60.
- 2. From Milano Linate airport to Milano Centrale station: bus or taxi to Stazione Centrale (takes 20 mins)

<u>By Train</u>

Trains run every hour from Milano Centrale to Bergamo from 6.05 to 23.40; for more detailed information, see the timetable of the Italian Railway Company, <u>http://www.trenitalia.it/</u> - which has websites in English. Cost: € 5,5.

How to get from Bergamo train station to the Hotel

The hotel is 900 m from Bergamo railway station and can be easily reached on foot. Take Via Papa Giovanni XXIII (in front of the station), and after 900 m you will see the hotel on the right.

Alternatively, you can take the bus (#1, direction: Città Alta) in front of the railway station: it stops just in front of your hotel (4 stops, ca. 5 minutes).



How to get from the Hotel to the Venue

The venue is 1.2 km from the Hotel. You can reach it by foot or take the bus (#1, direction: Città Alta, 2 stops, ca. 5 minutes + 4 minutes by foot)



Program

	October, 10th University of Bergamo – S. Agostino – Aula 1 'Walter Fornasa'
09.30-10.00	Welcome and Introduction – Inaugural speech of the Rector of the University of Bergamo
10.00-10.45	<u>Opening Lecture: The Mediatory Role of Images</u> Jürgen Renn (Max Planck Institute for the History of Science, Germany)
10.45-11.15	Coffee break
	Transmission – Chair: Niccolò Guicciardini (University of Bergamo)
11.15-12.15	<u>Vision on Vision: Early Modern Scientific Images on Cosmology Explored by Means of Second</u> Order Images
	Matteo Valleriani (Max Planck Institute for the History of Science, Germany - Technische Universität Berlin, Germany)
	Florian Kräutli (Max Planck Institute for the History of Science, Germany)
12.15-13.00	<u>The Illustrated Printed Page as a Tool for Thinking and Transmitting Knowledge. The Case of</u> <u>Renaissance Astronomical Books</u> Isabelle Pantin (École Normale Supérieure de Paris, France)
13.00-14.30	Lunch
14.30-15.15	Artistic "Libido" and Scientific Truth in 16th Century Woodcut Illustrations Magdalena Bushart (Technische Universität Berlin, Germany)
15.15-15.45	Coffee break
15.45-16.30	<u>Capturing, Modelling, Overviewing and Making Credible: The Functions of Visual at the</u> <u>Accademia del Cimento</u> Giulia Giannini (University of Bergamo, Italy)
19.30	Dinner
	October, 11 th

University of Bergamo – S. Agostino – Aula 1 'Walter Fornasa'

Transmission – Chair: Franco Giudice (University of Bergamo)

- 09.30-10.15 <u>Visual Culture of University Knowledge: The Lecture Notebooks from Louvain and Douai</u> (17th-18th centuries) Gwendoline de Mûelenaere (University of Louvain, Belgium)
- 10.15-11.00 <u>Nuclear Visions: Images and Epistemologies of the Planetary Crisis</u> Giulia Rispoli (Max Planck Institute for the History of Science, Germany)
- 11.00-11.30 Coffee break

	Transformation – Chair: Franco Giudice (University of Bergamo)
11.30-12.15	No pueden la pintura de mi pluma y palabras dar tan particular razón [] sin el pincel o debujo, y aun con esto serían menester los colores. Images and Artifacts in the Invention of the <u>Americas</u> Elena Paulino Montero (UNED -Universidad Nacional de Educación a Distancia)
12.15-13.00	<u>Marcello Malpighi and His Observations of the Chick in the Egg</u> Sietske Fransen (University of Cambridge, Great Britain)
13.00-14.30	Lunch
14.30-15.15	<u>The Transformations of Physico-Mathematical Visual Thinking: From Descartes to Quantum</u> <u>Physics</u> Enrico Giannetto (University of Bergamo, Italy)
15.15-16.00	<u>Ethnosciences and the Representations of Space in the Time of Climate Change</u> Elena Bougleux (University of Bergamo, Italy)
17.30-18.30	Walking tour of the Upper Town of Bergamo (with English-speaking guide)

October, 12th
University of Bergamo – S. Agostino – Aula 1 'Walter Fornasa

Exploration- Chair: Elio Nenci (University of Milan, Italy)

- Theorizing Technology: Theoria, Diagram, and Artifact in Hero of Alexandria 9.30-10.15 Courtney Ann Roby (Cornell University, USA)
- 10.15-11.00 Visualising Biodata in the Laboratory. Image-makers, Practices and Reinvention in Magnetic Resonance Technology Silvia Casini (The University of Aberdeen, Scotland)
- 11.00-11.30 Coffee break
- 11.30-12.15 Representing Experience in the Early Royal Society. The Case of Robert Hooke's Micrographia <u>(1665)</u> Salvatore Ricciardo (University of Bergamo, Italy)
- Arguing from Appearance: The Numerical Reconstruction of Galactic Tails and Bridges 12.15-13.00 Matthias Schemmel (Max Planck Institute for the History of Science, Germany)
- 13.00-14.30 Lunch
- 15.00-16.30 Visit to the Pinacoteca "Accademia Carrara"