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Visual representations in science

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We live in a world of images. Yet, we are poorly trained to deal with them. The study of the visual has traditionally been confined to art education. However, the world of images is much wider than what the artistic canon considers as its own. Decades ago, historian and art critic James Elkins made a call for a new history of art which would expand its iconographic repertoire, since – he stressed – the art canon addresses in fact a very small selection of all images. Elkins emphasized the interest in focusing on those images whose major aim is considered to be conveying information, in particular, those in the domain of science, technology and medicine.[1]

The study of visual representation in science had remarkable contributions long ago, especially in connection with the European Renaissance. It seemed particularly relevant for this cultural context, in which the sciences and the arts were hardly demarcated or different. The study of early modern science and art has produced works that are classics, such as those by Martin Kemp on 'the science of art' and Samuel Edgerton on the place of linear perspective in the rise of modern science.[2] There were also early attempts to bring the study of visual representation to the centre in history of science, such as Martin Rudwick's groundbreaking paper on the role of visual language in the making of geology as a discipline.[3] If the study of the visual has not become mainstream in history of science, it has attained nevertheless a certain level of popularity in the works of scholars such as Ludmilla Jordanova and Patricia Fara (with their focus on portraits) and in wide-ranging epistemological histories such as Lorraine Daston and Peter Galison's *Objectivity*.[4]

However, in the last three decades a large amount of literature has been produced which deals with visual representations as major tools in scientific practice itself. This body of scholarship is characterized by its diversity, stemming from sociological, philosophical and historical roots and running across different sciences and time periods.[5]

While indicating the urge of more comprehensive historiographical and methodological proposals based on synthesis and comparison, this scholarly production shows the importance of the visual in the daily work of scientists past and present, and indicates the major role that the study of visual representations shall play in future history of science, technology and medicine.

The papers presented in this special issue arise from the 6th European Spring School on History of Science and Popularization whose aim was to offer a wide range overview on current research on visual representations in science, technology and medicine and key avenues for its future development. The School counted with three keynote speakers Nick Hopwood, Daniela Bleichmar and Klaus Hentschel, whose work represents major contributions to the field,[6] and

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[1] Elkins, J. (1999) *The Domain of Images*, Cornell University Press, 3–5.

[2] See for instance Kemp, M. (1990) *The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat*, Yale University Press and Edgerton, S. (1976) *The Renaissance Discovery of Linear Perspective*, Harper and Row.

[3] Rudwick, M.J.S. (1976) The Emergence of a Visual Language for Geological Science 1760–1840, *History of Science* 14, 149–195.

[4] Jordanova, L. (2000) *Defining Features: Scientific and Medical Portraits, 1660–2000*, Reaktion Books; Fara, P. (2003) *Newton: The Making of Genius*, Picador; Daston, L. and Galison, P. (2007) *Objectivity*, Zone Books. See also Fara's numerous contributions in this journal.

[5] For historiographical reviews, see Jordanova, L. (1990) Medicine and Visual Culture, *Social History of Medicine* 3, 89–99; Pang, A. S.-K. (1997) Visual Representation and Post-constructivist History of Science, *Historical Studies in the Physical and Biological Sciences* 27, 139–171; Elkins, J. (1999) Art History and Images that are not Art. In *The Domain of Images*, pp. 3–12, Cornell University Press; Baldasso, R. (2006) The Role of Visual Representation in the Scientific Revolution: A Historiographic Inquiry, *Centaurus* 48, 69–88; Burri, R.V. and Dumit, J. (2007) Social Studies of Scientific Imaging and Visualization. In *The Handbook of Science and Technology Studies* (Hackett, E., Amsterdamska, O., Lynch, M., and Wajcman, J., eds.), pp. 297–317, The MIT Press; Nikolow, S. and Bluma, L. (2008) Science Images between Scientific Fields and the Public Sphere. An Historiographical Survey. In *Science Images and Popular Images of Science* (Hüppauf, B. and Weingart, P., eds.), pp. 33–51, Routledge; Dupré, S. (2010) Art History, History of Science, and Visual Experience, *Isis* 101, 618–622. A selection of major general studies produced in the last two decades includes: Lynch, M. and Woolgar, S. (1990) *Representation in Scientific Practice*, MIT Press; Lynch, M. (1991) Science in the Age of Mechanical Reproduction: Moral And Epistemic Relations Between Diagrams and Photographs, *Biology and philosophy* 6, 205–226; Ferguson, E.S. (1992) *Engineering and the Mind's Eye*, MIT Press; Mazzolini, R., ed. (1993) *Non-Verbal Communication in Science prior to 1900*, Olschki; Cartwright, L. (1995) *Screening the Body: Tracing Medicine's Visual Culture*, University of Minnesota Press; Baigrie, B.S. (1996) *Picturing Knowledge: Historical and Philosophical Problems Concerning the Use of Art in Science*, Toronto University Press; Cartwright, L., Treichler, P. and Penley, C., eds (1998) *The Visible Woman: Imaging Technologies, Gender and Science*, New York University Press; Jones, C.A. and Galison, P. (1998) *Picturing Science, Producing Art*, Routledge; Gooding, D.C. (2004) Envisioning explanations, the art in science, *Interdisciplinary Science Reviews* 29, 278–294, and (2004) Cognition, Construction and Culture: Visual Theories in the Sciences, *Journal of Cognition and Culture* 4, 551–593; Dijck, J. v. (2005) *The Transparent Body: A Cultural Analysis of Medical Imaging*, University of Washington Press; Pauwels, L., ed. (2006) *Visual Cultures of Science: Rethinking Representational Practices in Knowledge Building and Science Communication*, University Press of New England; Kemp, M. (2006) *Seen / Unseen: Art, Science, and Intuition from Leonardo to the Hubble Space Telescope*, Oxford University Press.

[6] See for instance Hopwood, N. (2006) Pictures of Evolution and Charges of Fraud: Ernst Haeckel's Embryological Illustrations, *Isis* 97, 260–301; (2005) Visual Standards and Disciplinary Change: Normal Plates, Tables and Stages in Embryology, *History of Science* 43, 239–303; Chadarevian, S. de and Hopwood, N., eds (2004) *Models: The Third Dimension of Science*, Stanford University Press; Hentschel, K. (2002) *Mapping the Spectrum: Techniques of Visual Representation in Research and Teaching*, Oxford University Press; Bleichmar, D. (2012) *Visible Empire: Botanical Expeditions and Visual Culture in the Hispanic Enlightenment*, University of Chicago Press.

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was structured in a series of workshops in which the three papers in this special issue were first presented.[7] The European Spring School, is an initiative of the Catalan Society for the History of Science and Technology, which, like *Endeavour*, presents cutting-edge research in an accessible manner that combines research and educational aims, and targets a wide range of audiences, including historians, scientists, teachers and the general public.

Exhibition displays, machine drawings, illustrated souvenir albums, engravings and photomechanical views of industrial sites, experimental graphs and tables, space-time diagrams, optical illusions and visual perception puzzles, geostatistical maps, computerized simulations, satellite photographs and physico-chemical landscape scans are presented in this special issue as objects whose production, circulation and use is fundamental to understand the making of modern science, yet complex to resolve into historical, philosophical and sociological explanations.

Frances Robertson investigates the role of objectivity in the making of visual languages, in the context of nineteenth-century British engineering. Engineers developed various styles of visual representation, not just those determined by the need of creating a standard visual knowledge for the production of machines. Robertson demonstrates that artistic skill, accuracy, precision, detail, abstraction and realism were qualities displayed alternatively by engineers, depending on their publics and professional targets and closely connected to professional and social prestige.

Aaron Wright moves us from the field and the workshop to the intersection between research and teaching practices. His study of the space-time diagrams of Roger Penrose illuminates the powerful connections between twentieth-century physics, art and psychology. Wright shows that the 'renaissance' of General Relativity taking place from the late 1950s owed a great deal to the development of new visual tools with heuristic power, which were shaped by forces connected both to research and pedagogy. These tools allowed new ways of seeing the relations between space and time, which transformed theoretical physics.

Tom Schilling deals with the making of economic and political knowledge through the production of visual representations based on field work in remote areas exploited by long-distance corporations. His analysis of the black-boxing of geostatistical data into digital images shows the role of visual tools in the making of expertise, the development of large-scale collaborative projects in contemporary science, and the impact of economic imperialism on local populations. Schilling demonstrates how new visual forms of representing scientific knowledge affect not only scientific practice, but also politics, economy and the people who, in order to deal with the economical, environmental and cultural impact of mining in their homeland, have inevitably to engage with the power and authority encapsulated in complex and foreign forms of (visual) knowledge.

Robertson's deconstruction of objectivity in the messy world of nineteenth-century engineering sets a rich comparative background for the exploration of the visual worlds characterizing contemporary science, as displayed in Wright's and Schilling's papers. Schilling's study deals with a classic endeavour in human affairs – cartographic representations of the world – which nowadays involves the entanglement of engineering and geographical knowledge with twenty-first-century computer imaging. Instead, Wright's account of twentieth-century physics takes us back to the past by suggesting relevant connections with visualization in the history of Renaissance science, as presented by scholars such as Kemp and Edgerton. Through their interdisciplinarity and breadth of analysis the three papers in this special issue show the major role played by visual representations in the making of scientific knowledge. The study of science read as a history of production, circulation and use of visual representations past and present.

[7] We would like to thank Nick Hopwood, Daniela Bleichmar and Klaus Hentschel for their generous involvement in the Spring School and their supervision of its workshops, and to the School participants, which contributed to make it an extraordinary experience. We are especially grateful to the authors in this special issue, to Mirjiam Brusius and Sophie Brockmann, to Ari Gross and Eleanour Louson, the editors of an excellent issue of *Spontaneous Generations*, and to Ignacio Suay-Matallana, Mar Cuenca-Lorente, Agustín López, Katy Barrett, Stephan Pranghofer and José R. Marcaida. The latter participated in a special issue published in *Actes d'Història de la Ciència i de la Tècnica* (2011). For the Spring School and its successive editions, see http://schct.iec.cat/school13/spring13_index.htm.