Visual Practices Across the University

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In 2005, I was working at the University College Cork in Ireland. Visual studies, film studies, and art history were expanding, and the time seemed right for a university-wide center for the study of images. I was interested in finding out who at the university was engaged with images, so I sent an email to all the faculty in the sixty-odd departments, asking who used images in their work. The responses developed into an exhibition that represented all the faculties of the university. It only had a couple of displays of fine art: one proposed by a colleague in History of Art, and another by a scholar in the History Department. Fine art was swamped, as I had hoped it would be, by the wide range of image-making throughout the university. The result was a book, *Visual Practices Across the University.*[1] The book is largely unknown outside of Germany, because the press, Wilhelm Fink, serves the German academic book market and does not concern itself with worldwide distribution or advertizing. (The book was published in Germany because most research on non-art uses of images is in German-language publications.) In this essay, I will report on the philosophic frame of the book, and give a sample of what it contains. To date it is the one of only two books that attempt to understand the full range of image production and interpretation in all university departments, including Engineering, Law, Medicine, and even Food Science.[2]

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[1]See Elkins (2007a), with contributions by thirty five scholars. This book is in English, and is available on Amazon Deutschland. This essay is adapted from the Preface, Introduction, and one of the chapters of the book. The exhibition was originally intended to be published along with a conference called "Visual Literacy", in a single large book. In fact the conference will appear as two separate books. The main set of papers in the conference, with contributions by W.J.T. Mitchell, Barbara Stafford, Jonathan Crary, and others, is Elkins (2007b); a second set of papers from the conference, on the subject of the histories of individual nations and their attitudes to visuality and literacy, will be forthcoming as *Visual Cultures.*

[2]The other is Beyer and Lohoff (2006); the glossary is on pp. 467–538. Their book surveys many more technologies than mine, and groups them according to an eclectic glossary

R. Frigg, M.C. Hunter (eds.), *Beyond Mimesis and Convention*, Boston Studies in the Philosophy of Science 262, DOI 10.1007/978-90-481-3851-7_8,

The book is an attempt to think about images beyond the familiar confines of fine art, and even beyond the broadening interests of the new field of visual studies. Outside of painting, sculpture, and architecture, and outside of television, advertizing, film, and other mass media, what kinds of images do people care about? It turns out that images are being made and discussed in dozens of fields, throughout the university and well beyond the humanities. Some fields, such as biochemistry and astronomy, are image-obsessed; others think and work *through* images. The humanities—not surprisingly—are in the minority when it comes to making and using images, and—perhaps surprisingly—they are generally *less* visual, less dependent on images, than other fields.

So far visual studies has mainly taken an interest in fine art and mass media, leaving these other images—which are really the vast majority of all images produced in universities—relatively unstudied. Outside the university, scientific images crop up in magazines, on the internet, in popular-science books, and in the familiar "art meets science" exhibitions. In those contexts images are often drastically simplified, shorn of much of the significance they had for their makers. In the book, I try to pay close-grained attention to the ways people make and talk about images in some thirty fields across all the faculties of a typical contemporary university. There are examples of the study of dolphins' fins, of porcelain teeth, of Cheddar cheese. In assembling and editing the various contributions, I was less interested in what might count as art or science, or in what might be of interest from an aesthetic (or anti-aesthetic) point of view, than I was in just *listening* to the exact and often technical ways in which images are discussed.

A great deal is at stake on this apparently unpromising ground. It is widely acknowledged that ours is an increasingly visual society, and yet the fields that want to provide the theory of that visuality—visual studies, art history, philosophy, sociology—continue to take their examples from the tiny minority of images that figure as art. At the same time, there is an increasingly reflective and complicated discourse on the nature of universities, which has as one of its tropes the notion that the university is "in ruins" or is otherwise fragmented. One way to bring it together, or at least to raise the possibility that the university is a coherent place, is to consider different disciplines through their visual practices. To begin a university-wide discussion of images, it is first necessary to stop worrying about what might count as art or science, and to think instead about how kinds of image-making and image interpretation might fall into groups, and therefore be amenable to teaching and learning outside their disciplines. Above all, it is necessary to look carefully and in detail, and not flinch from technical language or even from the odd equation.

All these points are theorized in the Introduction to the book. In this essay I will restrict myself to just one subject: the quality of the existing discourse between arts and sciences.

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of "visualization techniques" such as "Modell", "Notationssystem", "Objektklassendiagramm", "Phasendiagramm", "Piktogramm", "Prototyp", and "Radardiagramm". I find their book interesting as a resource, but I am more optimistic about organizing the material into a smaller number of conceptual units.

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Among the things that *Visual Practices Across the University* is not, it is primarily not a contribution to the many exhibitions and books that present scientific images as art, or as possessing the aesthetic properties or even the "richness" that supposedly inhere in art. I ignored the intermittent temptation to say such-and-such an image is beautiful, and I did not present any image, no matter how luscious, as possessing any aesthetic properties that its maker or its intended audience had not already claimed for it. My interest was the particular ways of talking about images in different fields, so I avoided generalized art-science talk about "beauty", "richness", "pattern", "symmetry" and other such concepts whenever I could.

(It happens that some ways of talking about images incorporate the kinds of broad claims about art or science that I would normally want to avoid, and it happens that people call one another's images "beautiful", but reporting on other people's use of such claims is different from using them to organize the argument.)

There are a number of examples of the kind of art/science talk I tried to avoid in *Visual Practices Across the University.* The most widely publicized recent conferences on science-art themes are Felice Frankel's two "Image and Meaning Initiative" conferences, the first at MIT in June 2001, and the second at the Getty Center in Los Angeles in June 2005.[3] Frankel is a science photographer, originally trained as a landscape and garden photographer, who rephotographs scientific experiments for publication.[4] In the past her work has raised interesting questions about the relation between her artistic choices and the scientists' visual preferences, especially when her rephotographs have helped scientists discover new features of their work that they had not seen.[5] Her books *On the Surface of Things* (2008) and *Envisioning Science: The Design and Craft of the Science Image* (2004a) present accomplished, colorful photographs of various physical and chemical phenomena. Frankel's conferences and books provide a chance for art photographers to think about scientific images, and for scientists to ponder such things as the place of beauty or art in visualization. Phenomena such as iridescence on an oil surface, colors generated by opal, and patterns of crystals on a surface, are visualized in great detail and with attention to composition and symmetry. The photographs' formal properties are, however, not theorized. Frankel presents her work as scientific photography and writes only as a technical photographer. She does not articulate the artistic influences on her own work, even though that history is pertinent because it guides her choices of compositions, colors, symmetries, and textures. Frankel's books therefore lack the analysis of artistic influences that might have enabled her to account for her photographic preferences. Her compositional choices, for example, are influenced—I assume mostly indirectly, without deliberation—by Abstract

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[3] See web.mit.edu/i-m/intro.htm. My review of the 2001 conference is Elkins (2001a).

[4] See web.mit.edu/felicef/

[5] In this context I am only giving the outline of the argument: an example is discussed in detail in Elkins (1999).

Expressionism, and by realist projects such as the Boyle Family's fiberglass castings. In art historical terms, her practice derives from several strands of modern painting and photography from the 1940s to the 1980s. Those precedents are not irrelevant, because they can illuminate the aesthetic decisions that appear, unexplained, simply as "beauty". And because she does not know the science except to the extent that it is explained to her, the scientific content of her images is seldom broached except in the most general terms. For the book *On the Surface of Things,* a prominent chemist provided very brief, nontechnical summaries of the relevant science—not enough to account for individual passages in Frankel's very complex and detailed images. The chemist's caption for Frankel's picture of opal, for example, describes how the colors of an opal derive from microscopic bubbles: but the photograph does not show the bubbles, and so its colors, and its very complicated planes of color and form—all of them captured in a way that would not have been possible before Symbolism and abstract painting, using modernist criteria of coherence, composition, and visual interest—are entirely uninterpreted by his commentary. The same happens when the chemist describes a pictures of a shimmering pool of oil. The description of iridescence cannot be understood by reference to Frankel's photograph, and the composition of her photograph—which is indebted, probably indirectly, to Antoní Tàpies and other abstract painters and sculptors—cannot be understood by reference to the chemical description of oil films.

As a result Frankel's projects miss the many specific connections between photographic decisions informed by the history of art, on the one hand, and by the scientists' purposes, on the other. Her photographs can only appear as mute testimony to her "eye", her unarticulated judgment of what counts as an interesting image. *On the Surface of Things* is a successful coffee-table book, because it can be read by scientists and artists; both will recognize meanings that are not spelled out, but neither will know how to make a bridge between the two domains. What is needed, I think, is an inch-by-inch analysis of her photographs, to bring out the individual artistic decisions and their histories, together with—matched line by line with—an inch-by-inch account of the scientific meaning of each form.

Frankel also writes a column called "Sightings" in *American Scientist* magazine, interviewing scientists about their images. One column is an interview with Jeff Hester of Arizona State University, who was one of the scientists who made the widely-reproduced Hubble Space Telescope image of young stars in the Eagle Nebula (1995; Fig. 1).

The interview is brief, only a few paragraphs; and because of its brevity, it is a good example of what I think of as the abbreviated, impoverished structure of much of this generalized art/science discourse. Hester tells Frankel how the image of the Eagle Nebula was combined from thirty-two images taken by four separate cameras, and how the images were stitched together, cleaned up, and given false colors. Blue, for example, stands for emissions from doubly ionized oxygen. The colors appear "representational", in Frankel's word—that is, they make it seem the photograph is a picture of mountains. Hester explains the image is more like a "map of the physical properties of the gas", but that, fortuitously, "it is also closer to what you

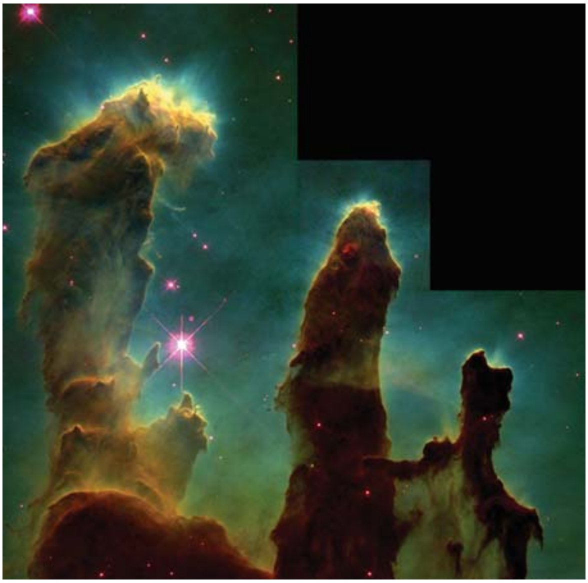

Fig. 1 Hubble space telescope image of young stars in the eagle nebula

might see through a telescope with your eye than is a picture taken with color film" (2004b, 462). Toward the end of the one-page interview, Hester says "the beauty of the image is not happenstance. When people talk about 'beauty,' they are talking about the presence of pattern in the midst of complexity".

Several things need to be asked about that claim if it is to make sense. It would be good to know why Hester felt he should mention beauty at all; I assume it was on account of the popular-science context of the interview, and the idea that beauty might serve as a bridge to a wider public. But what kind of bridge is beauty here? Instead of bringing beauty in, why not present the image as something wonderfully and unexpectedly complex—that is, after all, another alleged art-world value—by saying, as he had a moment before, that "there is one hell of a lot of information present"? But having mentioned beauty, why identify it with pattern recognition? That is not an association I think many people in art would have, unless they are following psychologists such as Rudolph Arnheim.

There are at least five assumptions at work in Hester's mention of beauty, and in Frankel's silence about it: that beauty is relevant, that the image is beautiful, that the meaning of beauty is clear, that beauty can help the image communicate to non-scientists, that beauty is an idea shared across the arts and sciences. Hester remarks that "the same patterns present in the image that make it aesthetically pleasing also make it scientifically interesting". If that were true—and to assent I would have to agree that beauty is present, and that beauty can be identified with pattern recognition—then it would have to mean something like this: If I appreciate the patterns in this image, I also appreciate the science. I think that is untrue, and it is not supported by what Hester says. He concludes that he and his collaborators "use color in the image in much the same way that an artist uses color", as an "interpretive tool". That may mean that the false colors he and his collaborators chose to represent emissions of oxygen, hydrogen, and sulfur are like the false colors artists chose, and it might also mean that artists also choose false colors that are at the same time like representational colors. Either way the parallel is too loose to do much work, and that is one of the reasons conversations like these are often so short.

An artist like Emil Nolde, who chose "false" colors as well as naturalistic ones, made his decisions for completely different reasons—and even using a different palette—than physicists who make false-color astronomical images. Scientists' choice of colors have specific histories, just as artists' choices. Some of the more garish productions of astronomical images owe their color choices to 1960s hallucinogenic art like *Yellow Submarine* or tie-dyed T-shirts. The Eagle Nebula image owes its color choices to the history of landscape painting and photography. It has a saturated, Kodachrome look that derives from nostalgic reworkings of 1950s photography, and it also owes something to the kitsch paintings popular in "starving artist" sales and exemplified for North American consumers by the painter Thomas Kinkade. (He paints tumble-down English-style thatched cottages, decorated with rainbow-colored flowers.[6]) I do not mean that any of these influences were direct, or conscious. The built-in color palettes of astronomical software, like the palettes in Photoshop, NIHImage, ImageJ, and other scientific image processing software, were often designed with certain aesthetics in mind—there are Cézanne-like palettes, and science fiction paperback-cover palettes. The salient point is that the colors are not often chosen only because they provide optimal contrast and legibility. Contemporary scientific practices are indebted to specific moments in the history of art, and it is the job of an observer in the humanities to make those connections.

In terms of forms, the Eagle Nebula image as it is presented here (it could have been cropped and oriented quite differently) belongs to the history of romantic landscape painting, from Arnold Böcklin and other German and French painters to the exaggerated mountains of the Hudson River School painters. It may even belong to the lineage of fantastical mountainscapes in Chinese painting, beginning in the Song Dynasty and continuing to the present. I do not mean any of this as a put-down: scientific images have their own lineages in the history of art, their own aesthetic histories. They are not merely or simply "beautiful"; and "pattern" has almost nothing to do with these historical lineages.

And even if artists were to agree that they use false and yet "representational" color "in much the same way", it would still be unclear what about the science has been explained aside from the fact that the colors were chosen to aid communication. Frankel's column does not explain how the image was generated, except in generalities; it does not explain the link that is proposed between art and science; and it does not explain the scientific content of the image. She asks no follow-up questions to Hester's opinions about beauty, art, and pattern.

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[6]Try www.thomaskinkade.com; there are many other sites and stores.

Hester's brief comments are made in an informal context, but they follow a logic that can be found in many other places. Examples could be multiplied indefinitely. In 2005 an article in *California Monthly,* Berkeley's alumni magazine, showcased the research of Berkeley scientists (Smock 2005). In this kind of article, a "pretty picture" (the term was apparently adopted by astronomers to denote images they prepared for calendars and posters) is briefly glossed by a text identifying the scholar who produced it. A full-page photograph of a moss-covered tree, for example, is accompanied by a text describing a Berkeley scientist who recovered medicines from moss, especially "a family of chemicals called flavenoids" (Fig. 2).

Nothing more is said. In the context of an alumni magazine, all that is expected is a nice picture and a reference, and it would be assumed that anyone who wanted could follow up and find out more. But these clipped contexts are ubiquitous, so it is significant that the text explains neither the photograph (What kind of tree? What kind of moss? Was the picture used in the research?) nor the science (What are flavenoids? How are they extracted?). A reader perusing the article is treated to several dozen photographs and short paragraphs. If they are interested, they can

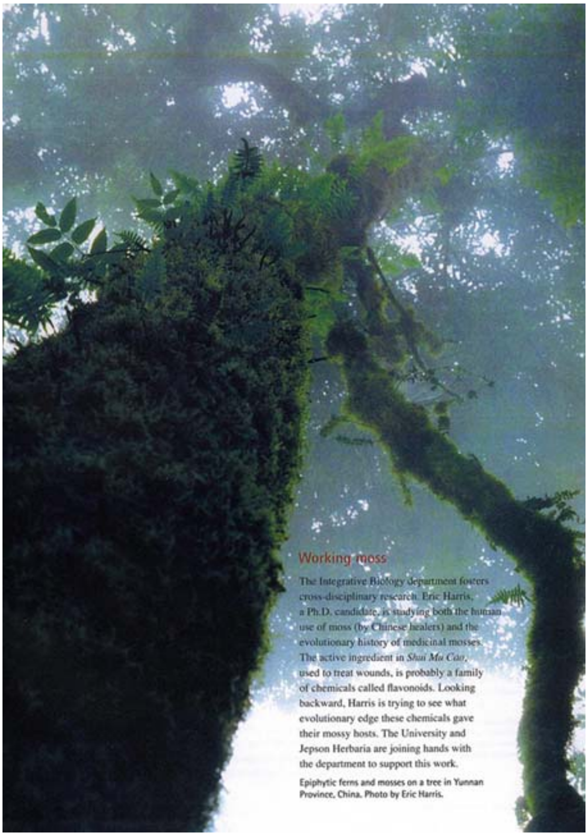

Fig. 2 Moss-covered tree: from Smock, "Picture This!" in *California Monthly* (March/April 2005), pp. 16–27. Courtesy Kerry Tremain, Editor, *California Monthly*

learn the names of the Berkeley scientists and guess at what they are doing, but the article is not really meant to teach anything. It is a wash of colorful images and new names, which suggests that lovely photographs can help laypeople understand a little science.

A few more examples will show how unquestioned this generalized art/science talk can be. In a lecture given in spring 2005 as part of the Einstein centenary, the physicist Michael Berry of Bristol University visited Ireland and gave a talk about the patterns of light that form on the bottom of swimming pools and the ceilings above swimming pools. The "caustics" and wave fronts were the object of his own scientific research, he said, and he also talked about the motion of wave packets and the physics of rainbows. He compared those phenomena to David Hockney's paintings, and to passages about reflections and light patterns in A.S. Byatt, Thomas Pynchon, and John Banville. The occasion was a "Café scientifique" sponsored in part by the British Council, and in that setting it would not have been appropriate to introduce much scientific content. Berry worked on the assumption that the audience found the images as beautiful as he did (I found them garish), and the theme throughout was that an appreciation of the beauty would provide a way to appreciate the science. The audience was appreciative because he was persuasive and animated, and because the images were full of color and light: but both the science and the art (I mean the Hockney) were done a disservice. Nothing could be gleaned about the physics of caustics from Berry's images, and his impoverished sense of artistic beauty made the parallels between artists like Hockney and the high-chroma scientific photographs unconvincing. But the event was a success—it was crowded beyond the room's legal capacity—and no questions were asked about "beauty" or scientific content.

In the art world, the same strategies of juxtaposing art and science, and implying that one seeps naturally into the other, produce work that can be taken tongue-in-cheek, as kitsch. An example at the margins of the art world is the company DNA 11, which will make framed pictures of your DNA.[7] Although their website simply identifies the images as DNA—and as "great art", and "one-of-a-kind masterpieces"—actually they are electrophoretograms, arranged in strips. They are unlabeled, making it virtually impossible to extract any scientific content from them. "The procedure we use", they write, allaying the possible objection that someone could extract information from their "art", "creates a unique fingerprint that does not provide any information about your genetic code. It is a unique, artistic representation of your genetic fingerprint". The framed prints they produce are beholden to a popularized aesthetic derived from minimalism: the color schemes they offer, and the frames that consumers can choose, all derive from second-generation minimalism in the 1990s. Their project can also be taken as just fun—which is to say as campy pseudo-science, or even kitschy sciencey minimalism. DNA 11's art credentials include the fact that it is advertised specifically as having no content: you can't learn about your DNA from your DNA art.

[7] www.dna11.com, accessed March 2006. I thank Curtis Bohlen for drawing my attention to this.

"Beauty" and "art" do not have much analytic purchase in any of these instances. Was Berry's use of the word that different from Ed Bell's praise of the computer graphics company Hybrid Medical Animation, when he said their animations "extend beyond the boundary of highly informative graphics: they enter the realm of high art, achieving a combination of Truth and Beauty"? Hybrid Medical Animations make Hollywood-style digital movies of proteins, antibodies, bacteriophages, and other microscopic phenomena (Fig. 3).

They use the latest textures (translucent surfaces, shining and viscous surfaces), vivid colors (magentas, lavenders) and all the bells and whistles of *Star Wars*-style action (tracking shots, zooms, fly-throughs, rapid point-of-view changes, simulated shallow focus). Their movies are like *Star Wars* or a Universal Studios theme park ride, but with molecules instead of actors. Bell is Art Director of *Scientific American;* his endorsement appears on Hybrid Medical Animation's web pages. "Beauty" would seem to mean something like "dazzling post-production-style visual effects"—different, I think, from Berry's "beautiful" which means something like "elegant curvilinear patterns not unlike Op Art", and from Hester's "beautiful" which means something like "patterns that can be universally recognized".

There is a longer history of displaying scientific images for their beauty. André Kertesz composed scientific images that way, but the most influential example was the philosopher Jean-François Lyotard's exhibition *Les Immatériaux,* which displayed bubble-chamber images as if they were analogues of gestural painters such as Tàpies or Cy Twombly (Centre de Création Industrielle 1985). Bubble chamber

Fig. 3 Hybrid medical animations' still of microscopic phenomena (c) 2006 Hybrid medical animation. Courtesy of Geoffrey Stewart info@hybridmedicalanimation.com

images are actually intended to be *measured* and then discarded, and not appreciated for any aesthetic property. The exhibition I curated in Ireland, “Visual Practices Across the University”, was intended to break with the tradition of Kertesz and Lyotard and the many people who follow in their wake. In the exhibition, each person or group of exhibitors displayed a single large image. Visitors were meant to be attracted by the large, unusual images, the way a reader of *California Monthly* might be attracted by the pictures of outer space, molecules, and mossy trees. Then when the visitors approached more closely, they found that the pictures only *appeared* to be accessible, and what little they shared with art—their compositions, their colors—was not helpful or interesting.

The opposite also happens: scientists write about artworks as if art’s main interest is its scientific content. Thomas Rossing and Christopher Chiaverina’s *Light Science: Physics and the Visual Arts* (1999), which finds scientific themes in pointillism, anamorphosis, and op art, is an example: it argues that a principal source of interest in the art is its illustration of basic scientific concepts.[8] Leonard Shlain’s *Art and Physics: Parallel Visions in Space, Time, and Light* (1991) is a more concerted effort to find links between science and art. But Shlain is too easily satisfied by chance coincidences, metaphoric connections, and miscellaneous affinities.[9] The same could be said of other books, including John Latham’s *Art After Physics* (1991) and Arturo Gilardoni’s *X-Rays in Art* (1977). The common ground of these books is a dual claim: first, that art can be interesting because it demonstrates science; second, that it is not incumbent on someone writing about the science in art to account for the apparent irrelevance of the existing non-scientific interpretations of the art.[10]

A large critical and journalistic literature rose in the wake of a book by David Hockney and Charles Falco called *Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters* (2001), which claims that some old masters used mirrors and other optical devices to help them make naturalistic paintings. There was an enormous conference on the theme in December 2001 at New York University, and several of the people involved continued to publish on the subject in the years

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[8]For a review, see Stroke (2001); Stroke notes the asymmetry of the book, which concentrates on the influence of science on art, and notes that artists sometimes influence science. His example is Leopold Godowsky, Jr., and Leopold Mannes, who invented the Kodachrome process; but Stroke observes they both also had physics degrees.

[9]His website glosses his book by claiming that “despite what appear to be irreconcilable differences, there is one fundamental feature that solidly connects ... evolutionary art and visionary physics. [They] are both investigations into the nature of reality. Roy Lichtenstein, the pop artist of the 1960s, declared, ‘Organized perception is what art is all about.’ Sir Isaac Newton might have said as much for physics”. It would be extremely difficult to find another artist who says that, and just as hard to define what it might mean. What art is made from “disorganized perception”? And what is “evolutionary art” anyway? Shlain, at www.artandphysics.com.

[10]The most promising project along these lines is John Onians’s research at the World Art Studies Centre at the University of East Anglia, which is a patient and systematic search for things that particular branches of science—especially neurology—can say about art; see Onians (2007).

following. (My criterion of an enormous conference is that ninety seats were set aside just for journalists, and lines went halfway around Washington Square in Manhattan.) Essentially Hockney and Falco claimed that painters from Van Eyck onward had access to optical aids such as mirrors, camera lucidas, and lenses that helped them achieve the feats of naturalism that have been traditionally attributed to their innate skill. The book and conference were a sensation in the media, in part because they seemed to empower ordinary viewers—at last, so it was said, viewers do not have to listen to the increasingly arcane meditations of academics, because they can see for themselves how the paintings were made.[11]

Ellen Winner, a psychologist who gave a paper at the conference, later wrote an essay called "Art History Can Trade Insights With the Sciences", calling for a mutual respect that she felt was missing at the conference. "True", she writes, "Falco and Hockney did not speak to the meaning or beauty" of the art, but that does not imply there are no lessons to be learned by considering the science. "When art historians argue that artists did not *need* lenses because they were so talented, they seem not to realize that the argument does not rule out the use of lenses" (2004, B10). The gulf of misunderstandings I have been trying to describe is nicely contained in that sentence, because regardless of the truth of Hockney's claim, it is not true that "art historians argue that artists did not *need* lenses": they scarcely mention those things at all. The two discourses are much further apart than Winner's claim implies, and it is not likely that more than a half-dozen humanists and cognitive scientists are "going to be teaming up to study humanistic phenomena from a scientific perspective". In order for that to happen, there has first to be an agreement over the common problems, whether they are beauty or optics.

Sidney Perkowitz, another scientist who attended the conference on Hockney's book, had written a book called *Empire of Light* (1996). In the article he contributed to the conference, he says he is neither surprised nor dismayed that some artists used optical aids. "Should the use of a tool diminish the value of the art?" he asks, and he illustrates a painting by Chardin, an Op-Art abstraction, and Mondrian's *Broadway Boogie-Woogie.*[12] The question isn't wrong, but wrongheaded. To whom does it matter that Chardin or Mondrian "reflect principles of visual cognition"? That has seldom been a part of their significance, and if the idea is to find examples of visual cognition, there is no good reason to adduce art to begin with. At the conference I had a brief argument with Perkowitz. I suggested that very few contemporary artists even use science in their work—I named Vija Celmins, Dorothea Rockburne, and Mark Tansey—and he said I was wrong, that his book had many examples of "new forms of art" produced by the use of science. His essay features an artist named Dale Eldred (I had not heard of him), and his book has many more minor artists. I wonder if their marginality in the art world does not prove

[11] Notably David Stork and Charles Falco. My responses are a review of Hockney (2001), on the College Art Association review site at www.caareviews.org/hockney.html and a review of the NYU conference in Elkins (2002). The paper I delivered at the conference is Elkins (2001b); I have also rehearsed these argument in Elkins (2008a).

[12] webexhibits.org/hockneyoptics.

the point. Art that is strongly inclined to technology or science often—though not always—ends up on the margins of the art world. The large annual conferences of SIGGRAPH and ISEA are cases in point; both organizations feature digital art, and both are almost completely ignored by the mainstream art world. In some measure that is a prejudice, and a fault, of the art world: but in some measure it shows that scientific and technological themes just aren't part of the mainstreams of postmodernism.[13]

The principal humanist scholars who study the science of art, such as Martin Kemp and John Gage, have done much of what can be done on the scattered appearances of scientific content in Western art[14] (Kemp 1990; Gage 1993). The end point of such research is the fact that science has rarely constituted much of what matters in art. The complementary end point of the scientific interest in art, such as Thomas Rossing and Christopher Chiaverina's, or Leonard Shlain's, should be that scientific explanations rarely matter in humanist discourse on art. If discourse on science-art connections is rum, uninformed, unhelpfully abbreviated, unjustifiably optimistic, alienating, and generally unhelpful, then it may be time to find new ways of talking about images that are not art.

I have been arguing that public talk and journalism about art and science is a kind of faux-discourse: it has the appearance of creating meaning, but it often fails to do so because the two sites of knowledge, historical or critical and scientific or technical, are too generalized to make contact. Even the small amount of academic writing on art and science, such as Martin Kemp's, only attains its purchase by narrowing its focus to very small extracts of art history.

One way to improve this situation would be to avoid generalized tag-words like "beauty", "elegance", and "pattern", and another way would be to avoid setting up contrasts between science and art.

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The book, *Visual Practices Across the University,* is not my first attempt to find a way of thinking that could include all sorts of images at once. The other projects are relevant here, because they form the background and justification for *Visual Practices*. The first was *The Domain of Images* (1999), which divides images first into three groups (writing, pictures, and notation), and then into a set of seven. The triad writing, pictures, and notation was intended to capture the fact that mathematical images are used and talked about differently than written language or visual images. The division into seven was partly borrowed in part from Ignace Gelb, who was Derrida's source for "grammatology". The seven included allography (calligraphy, typefaces, and the visual elements of writing), subgraphemics (writing-like

[13]I am not criticizing all technologically-oriented art; my main target is the perception of the mainstream art world. For a full argument see Elkins (2005).

[14]This point is elaborated in my review of Kemp (1990) in Elkins (1991) and also in Elkins (1999).

fragments of images), and emblemata (highly organized symbolic images). *The Domain of Images* is a long and complicated book, and it has the conceptual narrowness that any taxonomy imposes on itself. Its crucial limitation, as the art historian Robert Herbert pointed out, is that it has to renounce some of the history of the objects, and virtually all of their political and social contexts, in order to make sense of how they have been received. Emblemata, for example, are interpreted in distinct and definable ways—they have an inner logic, a lexicon, and protocols of reading that make them recognizable and legible—but in order to analyze the differences between emblems and other, less organized images, it is necessary to suspend an interest in the history or social contexts of individual emblems. *The Domain of Images* subordinates the purposes images serve to the ways people interpret them, and in that respect it is, in the end, a formalism.

The book *How to Use Your Eyes* (2000) took an entirely different approach. It has thirty-odd very short chapters describing such things as "How to Look at the Night Sky", "How to Look at a Twig", "How to Look at a Shoulder", "How to Look at an Engineering Drawing", and "How to Look at Sand". Each chapter gives as many names and terms as I could find about each subject: the half-dozen sources of light in the night sky aside from the moon and stars; the "leaf scars" that make it possible to identify trees in the wintertime; the names and motions of muscles in the shoulder. The book is full of pictures and unusual words. Half the chapters are objects made by people—the script Linear B, Japanese calligraphy, paintings, scarabs—and half are natural objects—moths' wings, sunset colors, twigs, grass, sand. *How to Use Your Eyes* is empirically minded, and was rightly said to depend on technical nomenclature: its methods do not work on objects that have few names or parts. As one reader said, it ends up making seeing into reading. I am not sure of the force of that claim, because it can be argued that the world only becomes visible through language, when an object has a potential name—but the book is certainly limited to visual objects that have already been extensively labeled.

Visual Practices is more technical than *How to Use Your Eyes,* and more careful about the disciplines that produce knowledge than *The Domain of Images. Visual Practices* is partly meant to be an example of what the field of visual studies might accomplish if it were to relinquish its lingering interest in art. Visual studies continues to grow very rapidly but I think it effectively remains in an academic ghetto, confined by its concerns with mass media, fine art, and politics.[15] First-year classes taught as introductions to the visual world continue to take most of their examples from Western fine art and mass media, and to a lesser extent from design, craft, and non-Western practices. When objects outside of art are considered, they are treated in a general way, as examples of production or politics. Scientific and other non-art images are adduced to enrich the cultural contexts of fine art or to explain references in individual artworks. Science is seen indistinctly, from a distance.

(This is more true in North America and the UK than in German-speaking countries and in Scandinavia. There, visual studies is frequently more attentive to

[15]The argument I am alluding to here is given in Elkins (2003).

non-art images. Examples include Gottfried Boehm's and Andreas Beyer's "Iconic Criticism" initiative in Basel, Horst Bredekamp's work at the Humboldt-Universität Berlin, and individual projects in Karlsruhe, Copenhagen, Aachen, Stockholm, Magdeburg, Leipzig, and Lund. This book fits more with German-language scholarship than with English- or French-language work, which continues to stress political, gender, and wider social meanings.)

The founding gambit of visual studies in English-speaking countries is that in a world of proliferating images, it no longer makes sense to have specialists on every conceivable kind of image, as it had once been useful for art history departments to have specialists on medieval, Renaissance, Baroque, and modern art. Visual studies posits that what matters is a more abstract, reflective concept of the production and dissemination of images, and a methodology capable of revealing the ways images are made to seem compelling, and how they reform their viewers and shape their desires. That has been a fruitful direction for several decades, and it may continue to be: but it does not address what happens in the sciences, for the simple reason that it elides the specific content of non-art images even as it pays close attention to the specific content of art and mass media. The American World War I poster with the legend "I want you!" has been analyzed in several visual studies publications, but there is still nothing in visual studies that analyzes a gene map in such a way that a student could explain what its parts signify. *Visual Studies* is intended to discover what it would sound like to pay attention to all images, art and non-art alike, with the level of detail used by their makers and their intended public. (Detailed engagement is, I think, indispensable: in the book, I made a few images myself, using scientific software and laboratory equipment. Only by operating the instruments, and learning the software, is it possible to see the limits of a humanities-based visual studies.)

The exhibition was difficult for viewers, and the book is not easy to read. Its chapters are like a collection of short stories: they have different characters and plots, but like stories by a single author, they share a number of themes, passing them back and forth, sometimes developing them, sometimes not. An editor who saw this book in manuscript said that it was too "particulate"; to her, the chapters seemed disconnected and too much concerned with the recitation of facts. This book is designed that way, instead of as a single continuous narrative, because I think that disjunctions are exactly what the field of visual studies needs in order to move forward. Texts on visual studies by W.J.T. Mitchell, Nicholas Mirzoeff, Mieke Bal, and others are limited by their strengths, as it were: they offer continuous theorizations in non-technical prose, but in doing so they exclude ideas that cannot be accommodated by humanities-style narration. What is at issue here, from the standpoint of visual studies, is the sense of appropriate theorization. The thirty practices in my book embody a number of themes, but the individual visual practices are not subsumed by those themes. Discontinuous, "inappropriately" factual, surprisingly technical, "particulate", apparently under-theorized visual encounters are exactly what I think will produce a genuine advance in theorizing the visual, an advance that will propel visual studies out of the humanities and into the wider practices of the university.

One more project needs to be added to this sequence. From 1998 to 2008 I wrote a book called *Six Stories from the End of Representation: Painting, Photography, Astrophysics, Microscopy, Particle Physics, Quantum Physics 1985–2000* (2008b). It considers six fields, two in the arts and four in the sciences, and studies them in six separate chapters. I make no connections at all between the six fields, and I do not present any over-arching theme. The idea is to let each discipline speak in its own words, in full technical detail, and not to popularize anything. *Six Stories From the End of Representation* is a kind of reductio ad absurdum of *Visual Practices Across the University* : it goes at great length into just six fields, instead of sampling thirty fields, and it declines all opportunities to make connections. *Six Stories* is intended to display the weaknesses of popularizing and abbreviating, and to pay whatever cost may be entailed in terms of readability, while *Visual Practices Across the University* contains an analysis—which I am omitting here—of the common themes of image-making that bind the university, improbably, into a coherent whole.

Those are the projects that led up to *Visual Practices Across the University,* which takes a more radical and thoroughgoing stand on these issues. I hope I have said enough to indicate why the book cannot be condensed or summarized. Instead I will close with a sample chapter.[16] I choose a chapter on the visualization of viruses, but like the other twenty-nine chapters, it stands on its own as an image-making and image-interpreting practice that is every bit as rich, difficult, and rewarding as discourse on paintings or sculptures. I will end with a brief conclusion.

3

The biologist Stephen Harrison wrote an essay called "What Does a Virus Look Like?" (1991). In it he considered over ten different kinds of images of viruses, made with different instruments. They are not all compatible—they cannot be assembled into one perfect picture. Harrison concluded that viruses don't "look like" anything except the sum total of those images.

William Wimsatt, a philosopher of science, has called this problem the "thicket of illustration": no one strategy will do, he notes, when it comes to picturing things as complex as DNA. Here we consider five different ways of producing images of viruses.

The Plaque Assay

Phages are obligate parasites of bacterial cells (Fig. 4). They have no intrinsic metabolism and are totally inert in the absence of their bacterial hosts. They attach

[16]This is chapter 29 in Elkins (2007a), titled "Visualising Viruses"; it was co-written by Stephen McGrath, University College Cork.

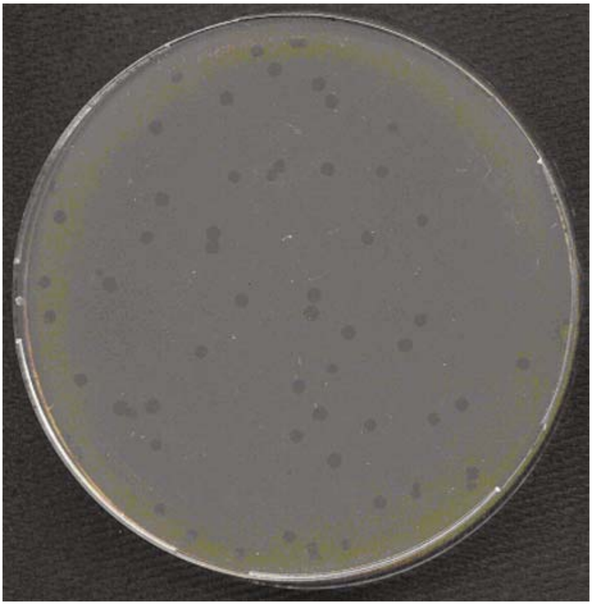

Fig. 4 An agar plate with bacterial cells and phages. Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

to the bacterial cells in a tail-first orientation, triggering the release of the DNA from the phage head, where it has been held under immense pressure.

The *plaque assay* is a method used in the laboratory to visualize the bacteriophage life cycle. An agar plate is seeded with a "lawn" of bacteria that has been mixed with some phages. The clear spots on the plate show where a phage has infected a bacterial cell and the progeny phages have killed the cells around it causing a clear zone or "plaque".

At this stage, no special optical equipment is necessary to locate the phages.

Transmission Electron Microscopy

The main structural features of phages can be seen in the large TEM image (Fig. 5). This is the lactococcal bacteriophage Tuc2009. Toward the top is the head, containing the DNA; then the tail; and at the bottom the structure that recognizes the host cells and contains the adsorption apparatus.

TEMs work on the analogy of light microscopes, but they shine a beam of electrons through the specimen. Whatever part is transmitted is projected onto a phosphor screen for the user to see. This is a typical, full-resolution TEM image; the original is 1280 × 1024 pixels in 16-bit grayscale—these images do not need to have ultrahigh resolution.

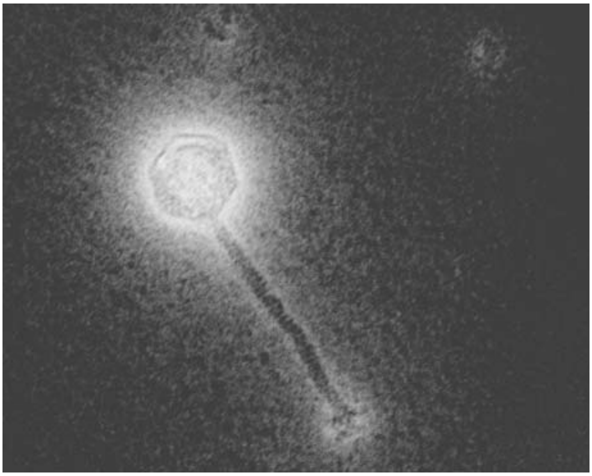

Fig. 5 Bacteriophage as visualized by transmission electron microscopy. Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

Gene Mapping

The first step in gene mapping is sequencing (Figs. 6, 7, and 8). The familiar base pairs of DNA—the rungs in its ladder—are sequenced. The graph that results is called a chromatogram (Fig. 6). The names of the base pairs can be read off the graph; the heights of the peaks show the confidence level of the analysis.

Figure 7 illustrates the genome of the bacteriophage Tuc2009. Its complete genome sequence has been determined and the individual genes contained within identified using a set of criteria based on the recognition of patterns and signatures in the DNA sequence. Each of the arrows represents an individual gene. The arrows are arranged in three rows, just to make them more visible. At the top of the image is a map of the parts of the phage that are formed by the different genes.

The colored arrows indicate genes coding for proteins to which physiological functions have been assigned. Red indicates that a function has been assigned on the basis of experimental work, whereas green denotes that a function has been assigned on the basis of the similarity of that protein to experimentally verified proteins encoded by other phages. Computer analysis allows us to predict which proteins will form part of the bacteriophage structure, but the actual visualization of these proteins is the only definitive proof.

The gene sequence in the Tuc2009 can then be compared with genes in other bacteriophages (Fig. 8). The genes occur in slightly different places, but they can sometimes be correlated, making it possible to determine some of their functions.

Electrophoresis

The electrophoresis technique is used to separate and visualise individual proteins in a biological sample (Fig. 9).

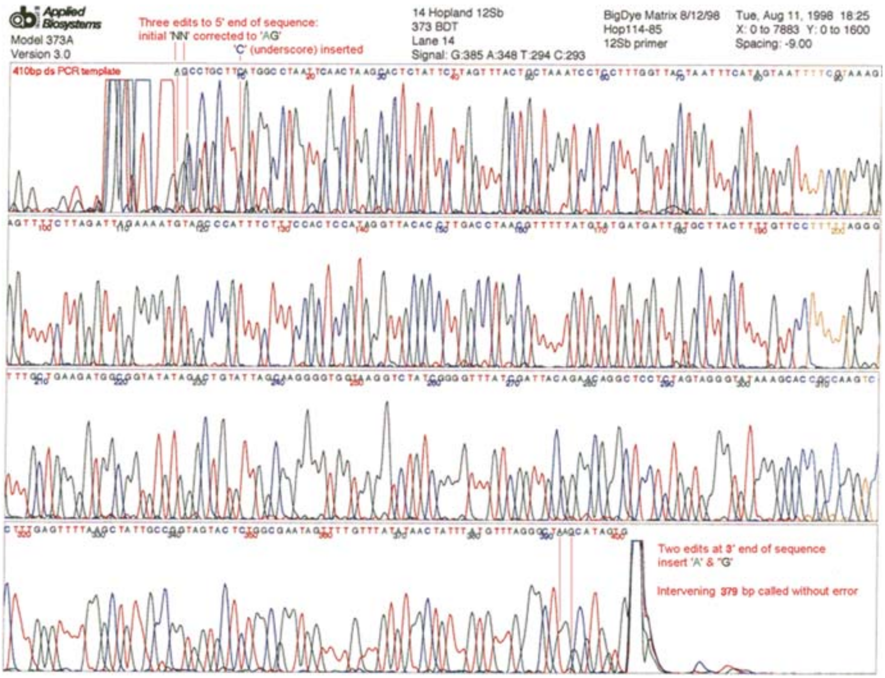

Fig. 6 Chromatogram of DNA sequence. Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

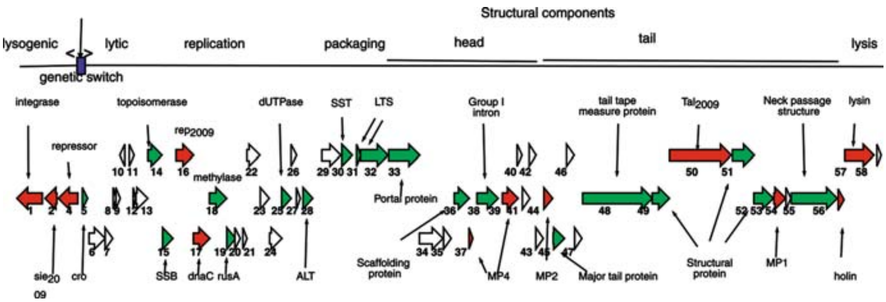

Fig. 7 Genome of the bacteriophage Tuc2009. Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

The protein bands in lane 1 represent a standard mixture of proteins of known size to which test proteins are compared. Each of the bands in lane 2 represent individual proteins that constitute the bacteriophage. Single bands representing individual proteins may then be cut from the gel and further analysed in order to determine the sequence of amino acids that they contain.

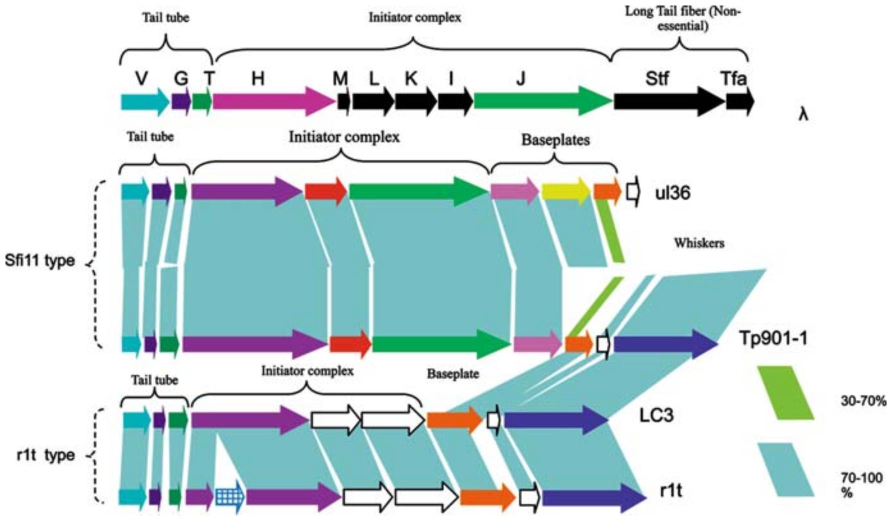

Fig. 8 Comparative genetic sequences of bacteriophages. Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

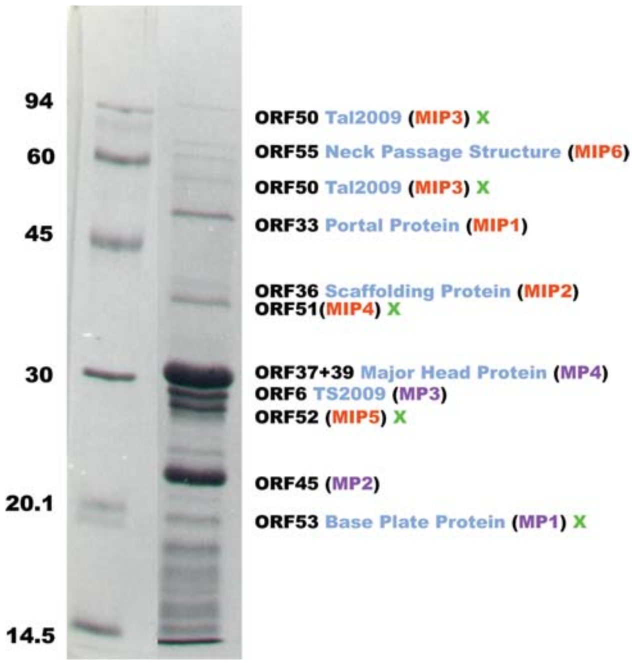

Fig. 9 Visualization of proteins by electrophoresis. Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

This type of analysis is dependant on the successful separation of the individual protein constituents into discrete homogenous bands as well as the presence of sufficient concentrations of proteins in these bands. The amino acid sequences may then be compared to those predicted from the gene map, thus allowing the identification of the structural proteins. Compare the labeled protein bands in lane 2 to the arrows in the gene map to see the location of the genes that encode the proteins.

Immunogold Electron Microscopy

Data from the electrophoresis analysis reveals whether a particular protein forms part of the phage structure or not, but it doesn't locate the precise location of the protein on the bacteriophage (Fig. 10). Antibodies that are highly specific for individual proteins may be generated using a variety of genetic and biochemical techniques. Labeling these antibodies with gold makes them appear as dense black spots when viewed under a transmission electron microscope. When the antibodies are mixed with the bacteriophage they specifically recognise and "tag" their cognate protein on the bacteriophage structure, thus marking the precise location of the protein.

The first panel is a TEM of the Tuc2009 bacteriophage without the addition of gold-labeled antibodies. Gold-labelled antibodies specifically recognizing individual proteins are added in the other pictures and are indicated on the panels. Their encoding genes are also included—the same numbers appear in Fig. 7.

The process of generating these antibodies can be laborious and expensive, and the success of the tagging of the specific protein on the phage is dependant on a

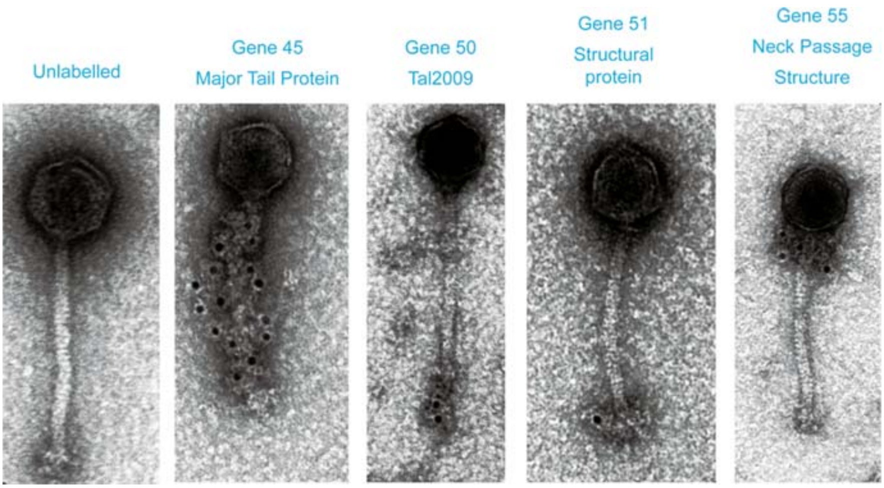

Fig. 10 Bacteriophage Tuc2009 "Tagged" and "Untagged". Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

number of critical factors such as the quality of the antibody and the accessibility of the protein on the phage structure to the antibody.

Other Kinds of Pictures

In addition to these kinds of images, virologists also make extremely detailed images of all the atoms in parts of the bacteriophages (Fig. 11). At the other end of the scale of detail, virologists find it useful to make schematic pictures of the different parts of the virus, to model how they might be put together (Fig. 12). Ideally, each part corresponds to a known gene (Fig. 13).

Conclusions

These are just eight of the ten or more methods of visualizing viruses. Clearly, no single representational method is sufficient. The opposite of the “thicket” of representation is the assumption, common in fine art, that a single image—say, the *Mona*

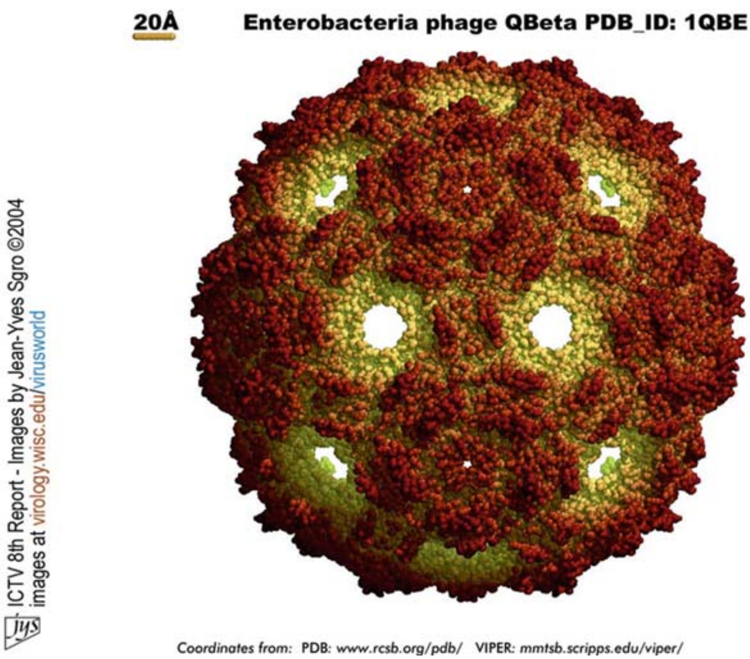

Fig. 11 Visualization of atomic components of a bacteriophage. Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

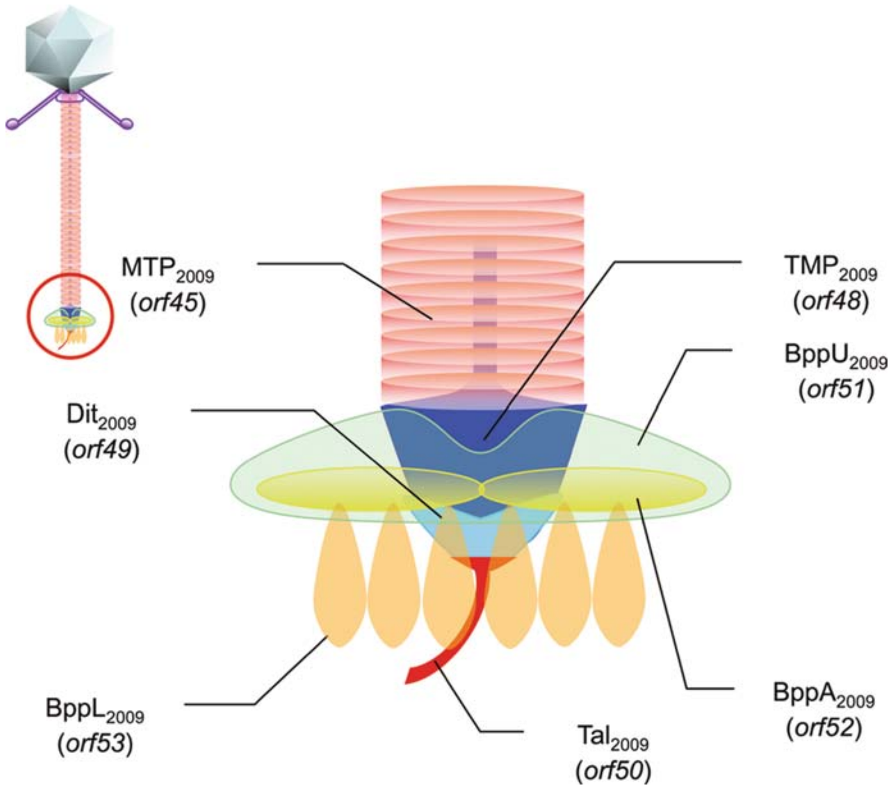

Fig. 12 Schematic model of virus structure. Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

Lisa —is not only sufficient but definitional for its subject. No further representations can even be imagined, except pastiches. In this case, however, the object does not exist except as a series of partly incommensurate representations.

*

This is the entirety of the chapter on viruses. Some chapters in *Visual Practices* have more connections to other chapters, but I did not force the links. In this case, the fascinating idea that some fields see the visual world as a "thicket" of structurally incompatible information could be extended to other fields, and contrasted against the case in fine art, where the single image is considered sufficient and even ideal. (Counter-examples could be found in conceptual art such as Art & Language, but they would be rare in the history of art.) People interested in the study of diagrams, graphs, and charts, and their relation to naturalistic representations, might find the study of viruses an especially rich field. But I would like to stress an abstract point:

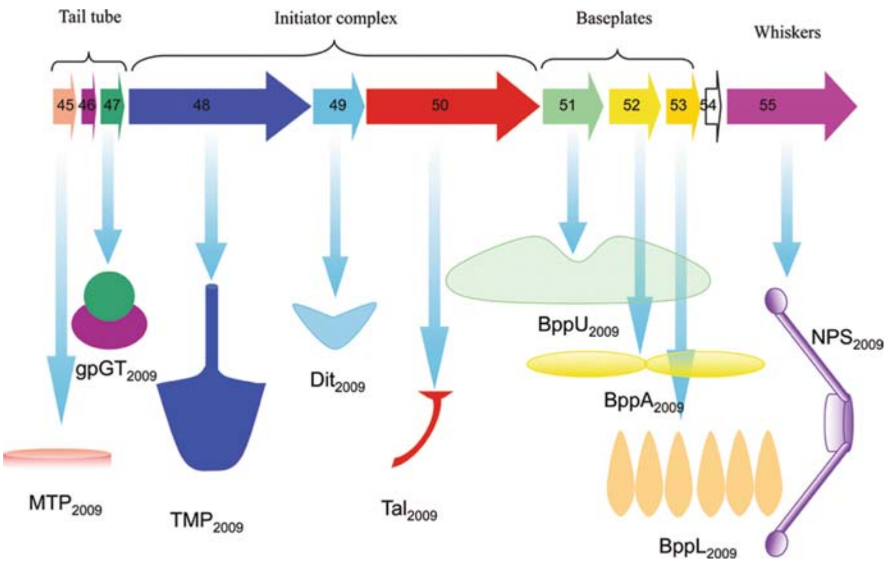

Fig. 13 Visualizing virus of known genes. Acknowledgements to Dr. Stephen McGrath, Microbiology Department, University College Cork

what matters here is the *exact* language of viral representation. A chromatrogram is different from an electrophoresis gel, and both are different from the Powerpoint animations scientists use to present their results. These are specific image technologies, and when they are subsumed under general philosophic categories such as resemblance, or general aesthetic categories such as beauty, or general formal categories such as pattern, or even general notational categories such as diagrams, their specificity—their language—is lost. The way forward through the impasse of generalized talk about art and science, is to bite the bullet and study technical and scientific imagery as it presents itself, in its own languages. Only then will it be possible to see how rich the field of images is, and only then will it become apparent that philosophy and art history do not own the interpretive tools to understand all of visuality.

References

Beyer, A. and Lohoff, M. (eds.) (2006), *Bild und Erkenntnis: Formen und Funktionen des Bildes in Wissenschaft und Technik*. Munich: Deutscher Kunstverlag.

Centre de Création Industrielle (1985), *Les Immatériaux*: *épreuves d'écriture*. Paris: Centre Georges Pompidou.

Elkins, J. (1991), "Review of Martin Kemp, *The Science of Art*", *Zeitschrift für Kunstgeschichte* 54, 4: 597–601.

Elkins, J. (1999), *The Domain of Images*. Ithaca, NY: Cornell University Press.

Elkins, J. (2000), *How to Use Your Eyes*. New York: Routledge.

Elkins, J. (2001a), "Who Owns Images: Science or Art?", *Circa* 97: 36–37, online at recirca.com/backissues/c97/elkins.shtml
Elkins, J. (2001b), "Optics, Skill, and the Fear of Death", online at webexhibits.org/hockneyoptics/post/elkins.html
Elkins, J. (2002), "Plucking at a Popular Tune", *Circa* 99 (Spring): 38–39; online at recirca.com/backissues/c99/elkins.shtml
Elkins, J. (2003), *Visual Studies: A Skeptical Introduction*. New York: Routledge.
Elkins, J. (2005), "Preface", in E. Kac, *Telepresence and Bio Art: Networking Humans, Rabbits, and Robots*, Ann Arbor, MI: University of Michigan Press.
Elkins, J. (2008a), "Aesthetics and the Two Cultures: Why Art and Science Should be Allowed to Go Their Separate Ways", in F. Halsall et al. (eds.), *Rediscovering Aesthetics: Transdisciplinary Voices from Art History, Philosophy, and Art Practice*. Stanford, CA: Stanford University Press.
Elkins, J. (2008b), *Six Stories from the End of Representation: Images in Painting, Photography, Astronomy, Microscopy, Particle Physics, and Quantum Mechanics, 1980–2000*. Stanford, CA: Stanford University Press.
Elkins, J. (ed.) (2007a), *Visual Practices Across the University*. Munich: Wilhelm Fink Verlag.
Elkins, J. (ed.) (2007b), *Visual Literacy*. New York: Routledge.
Frankel, F. (2004a), *Envisioning Science: The Design and Craft of the Science Image*. Cambridge: MIT Press.
Frankel, F. (2004b), "Seeing Stars", *American Scientist* 92, 5 (September–October): 462.
Frankel, F. (2008), *On the Surface of Things: Images of the Extraordinary in Science*. Cambridge: Harvard University Press.
Gage, J. (1993), *Colour and Culture: Practice and Meaning from Antiquity to Abstraction*. London: Thames & Hudson.
Gilardoni, A. (1977), *X-Rays in Art: Physics, Technique, Applications*. Mandello Lario: Gilardoni.
Harrison, S. C. (1991), "What Do Viruses Look Like?", *The Harvey Lecture Series*, vol. 85: 127–152; online at crystal.harvard.edu/lib-sch/HarrisonS∼91-HLect-85-127.pdf
Hockney, D. (2001), *Secret Knowledge: Discovering the Lost Techniques of the Old Masters*. New York: Viking.
Kemp, M. (1990), *The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat*. New Haven, CT: Yale University Press.
Latham, C. (1991), *Art After Physics*. Oxford: Museum of Modern Art.
Onians, J. (2007), *Neuroarthistory: From Aristotle and Pliny to Baxandall and Zeki*. New Haven, CT: Yale University Press.
Perkowitz, S. (1996), *Empire of Light: A History of Discovery in Science and Art*. Washington DC: John Henry Press.
Rossing, T. and Christopher C. (1999), *Light Science: Physics and the Visual Arts*. New York: Springer.
Shlain, L. (1991), *Art & Physics: Parallel Visions in Space, Time, and Light*. New York: Morrow.
Smock, W. (2005), "Picture This!", *California Monthly* 116, 1 (March/April): 16–27.
Stroke, H. (2001), "Light Science: Physics and the Visual Arts", *Physics Today* 54, 5 (May 2001): 60.
Winner, E. (2004), "Art History Can Trade Insights With the Sciences", *The Chronicle Review* (*Chronicle of Higher Education*) 50, 43 (July 2): B10.