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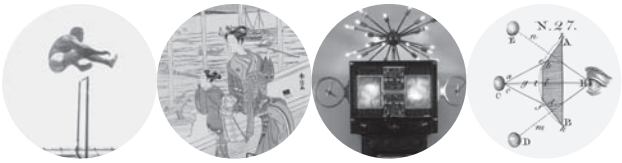

Science and Documentary: Unity, Indexicality, Reality

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Abstract

This article serves as an introduction to this Special Issue and explores in depth three concepts integral to the links between science and documentary: unity, indexicality, and reality. After outlining how and why the 'scientific' has been conceived as a problem in scholarship on documentary, the author offers an alternative framework based on recent scholarship in science and technology studies. This model seeks to account for the value of critiques of scientific approaches while recognizing the ways in which scientists have developed methods of image management that maintain the usefulness of their evidence while simultaneously recognizing the contingency of their truth claims. The author proposes that a conception of indexicality as both trace and deixis provides one tool for understanding the multiple strategies that scientists employ to figure reality.

Keywords

actor-network theory • indexicality • objectivity • realism • reality • unity

> To this day, documentarists cannot readily avoid the scientific, because that context is built into the cinematographic apparatus. So, when documentary filmmakers, such as Frederick Wiseman, liken their work to data collection or 'voyages of discovery,' they implicitly position their audiences as Latourian obstinate dissenters who have penetrated the lab of their film-making experiments. Watching 'actuality' on the screen is like watching the needles dance on the physiograph: the apparatus becomes transparent; the documentary becomes scientific inscription – evidence. (Brian Winston, 1995: 137)

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Scholarship on documentary has maintained an ambivalent relationship to science. Bill Nichols (1991: 3–4) describes documentary as having kinship with other non-fictional systems that serve as 'discourses of sobriety', such as science, economics, politics, and education. Like its kin, documentary is often regarded by the public as having a 'direct, immediate, transparent' relation to the real world. But at the same time, documentary's knowledge production has always been viewed with suspicion by practitioners within those hard scientific and social scientific fields. Its reliance on an image-based, illusionistic representational system both sparks the imagination and relies too much on the imagination to meet their requirements of rationality. M Norton Wise (2006: 79) writes that, according to scientists, images

> have often appeared, on the one hand, as much too powerful, likely to lead to the deceptive excesses of imagination rather than the calm reflections of reason, and, on the other, as much too weak, capable of illuminating only the surface of things rather than their deep structure.

He argues that the twin concerns with the reliability and depth of image-based knowledge production resulted in a series of 'unfortunate dichotomies' with which science is still wrestling.

It is within this discursive framework that contemporary documentary scholarship found itself. In the past two decades, critical studies of documentary media have argued that claims of directness, immediacy, and transparency demonstrate an inadequate understanding of the history and processes of documentary film and video production. While some scholars, such as Michael Renov, have pointed to the history of documentary production as evidence that filmmakers have consistently been aware of and celebrated the subjective aspects of documentary discourse (see Renov, 2004), others, such as Brian Winston (1995), have insisted that many apparent challenges still posit an untenable 'claim on the real'. The overwhelming majority of these critical interventions have urged a reassessment of documentary's alignment with the discourses of sobriety so as to account for the insights provided by postmodernist and poststructuralist critique of language systems and the politics of realist representation. And they have sought to do so while sustaining the political urgency that drew many filmmakers and scholars to documentary in the first place. But Bill Nichols (1991: 63) illustrates why this position poses a particular challenge to documentary:

> The problem is that the transparency and empowering capacity of language, the knowability of the visible world and the power to view it from a disinterested position of objectivity (not pathology), the assumption that transformation comes from persuasive intervention in the values and beliefs of individual subjects (not debates about the ideology of the subject as such) are the cornerstones of the documentary tradition.

In the critical discourse on documentary that accounts for such critique, then, disinterested objectivity, belief in the legibility of the historical world,

and its realization through realist representational strategies become values to be avoided. Science is associated with these values to the extent that 'documentary's scientific connection is the most potent legitimation for its evidentiary pretensions' – pretensions that must be fully relinquished (Winston, 1995: 137). And as Winston demonstrates in the epigraph, this association implicates producers and audiences. Documentary viewers and filmmakers, he later argues, must relinquish the association with a singular scientific objectivity and its concomitant truth claims. Doing so allows for the creation of a more honest, ethical, egalitarian media practice.

These scholars have aptly demonstrated the problems of aligning documentary with a positivistic theoretical view of nature and a singular methodological approach to communicating knowledge. Whereas the 'scientific' as an idea and method has received consideration in studies of documentary, scientific films – be they documentaries that concern scientific matters, educational films that speak to broad audiences, educational films that speak to specialized scientific communities, or research films made in support of scientific endeavors – have received little attention. The primary reason for this lack of attention is that other than the first category (documentaries that concern scientific matters – Errol Morris's *A Brief History of Time* being a notable example), these films are generally not considered films made in the documentary tradition. Carl Plantinga (1997: 1), for one, does not include them within his broader category of 'moving picture nonfictions, typically called documentaries or nonfiction films and television', although he does discuss subgenres such as 'independently produced features, journalistic documentaries, government-sponsored films, anti-war, anti-government films, public television programs, network "news magazines," compilation films, and poetic and experimental work'.[1] But in addition to the lack of attention, the question of whether 'the scientific' is in fact anything more than a convenient caricature is borne out by a consideration of actual science films, whose multiplicity and nuance provide ample evidence to refute the supposition of a monolithic positivistic scientific culture. As this issue will demonstrate, these films do deserve consideration as a vibrant part of the documentary tradition, a part that not only expands the bounds of the documentary but that also throws into relief and interrogates certain core concepts of that tradition.

The interdisciplinary collection of articles in this issue, written by film scholars, historians of science, and filmmakers, address both films made in the documentary tradition that concern explicitly 'scientific' matters as well as non-fiction films that participate in the process of scientific research – i.e. productions of visible evidence inside, outside, and across scientific communities. The aim in assembling this issue is less to argue for including these films within a sub-set of documentary and more to consider the historical and theoretical overlap that emerges, often in counter-intuitive spaces, when 'the science film' in its various guises is put in conversation with the documentary tradition. Many of the contributors' intellectual concerns will be familiar to scholars of film and media as well as to those

working in science and technology studies. They consider issues pertaining to: realism; indexicality; objectivity; the ethics, politics, and epistemological issues that arise when representing reality; the concept of experimentation with/on reality; the pedagogical potential of non-fiction film; and even the epistephilic and uncanny pleasures that result from the interaction with these images. As a whole, this issue of *journal of visual culture* brings together recent scholarship in science and technology studies and film studies with rigorous historical research on scientific and documentary practices in order to provide an enriched account of the links between science and documentary. Thus, we aim to rethink the relationship between science and documentary by reassessing its foundations and legacies.

Unity and Objectivity in Science

> If experiment is unnecessary, if theorists can understand the structure of the universe by sitting at their desks and doing beautiful mathematics, then these limits [to our technologically fixed scientific knowledge] do not matter much. But my personal view is that nature is much more clever and imaginative than we are. We particle theorists must not get too hung up on highfalutin' theoretical ideas like unification, no matter how appealing and beautiful, or we may lose our sense of wonder at the infinite variety of nature. (Georgi, 1994, quoted in Galison, 1996)

Recent scholarship in science and technology studies has challenged the notion that the sciences ever maintained a unified theoretical view of nature or a singular methodological approach. Peter Galison (1996), Nancy Cartwright (1999), Ian Hacking (1996), Richard Creath (1996), John Dupré (1995) and David Stump (Galison and Stump, 1996) to name just a few scholars, have argued that unities based in metaphysics, practical precepts, modes of communication, or even a core scientific mode of reasoning are all historically and theoretically contestable (see, in particular, Hacking, 1996). Galison (1996: 3) contends that while proclamations of scientific unity can be traced back to the Pre-socratics, the modern version of this notion arises in German-speaking countries in the mid-19th century when the ideal aligned with the struggle for German national unification. The well-known 20th-century version, exemplified by editors Rudolf Carnap, Otto Neurath, and Charles Morris's *Encyclopedia of Unified Science* (1938), is likewise associated with broader cultural struggles. Instead of national unity, this notion of a 'unified science' emerged in response to a rising tide of nationalism and racism enveloping the western world and, as such, supported an international or global perspective. It was not indicative, however, of the transparency of scientific meaning and knowledge production.

Ian Hacking (1996) has argued that there was even disunity in conceptions of unity in scientific thought. Victor Lenzen, for example, saw unification in terms of the creation of integrated scientific laws, applicable to quantum

mechanics, the theory of relativity, and all of empirical science. Carnap, on the other hand, understood unity not in ontological but in linguistic terms. For him, the laws of biology and the laws of physics could be expressed in everyday physical terms and procedures (Galison, 1996: 5). For Patrick Suppes (1978, quoted in Galison, 1996: 8), however, freedom is to be located in the multiplicity of languages. He writes, 'the irreducible pluralism of languages in science is as desirable a feature as is the irreducible plurality of political views in a democracy.' If the position taken by the *Encyclopedia of Unified Science* is to assert the rationality of the scientific approach as a defense against fanaticism and the abuse of power, Suppes's position reflects the more contemporary commitment to multiculturalism and belief in contextually-specific local knowledge as a challenge to cultural homogenization, domination and hierarchy.

Historians of science Lorraine Daston and Peter Galison (Daston, 1992; Daston and Galison, 1992, 2007) have likewise called into question the premises of a unifying and singular scientific epistemic value through their rigorous historicization of the concept of objectivity. Daston and Galison demonstrate that that the current concept of objectivity is the result of a series of developments through historically distinct but overlapping modes. Thus they detail the ascendancy and replacement of 'truth to nature', 'mechanical objectivity', and 'trained judgment'—each with its own meaning and distinct history. Daston's and Galison's work is receiving increasing attention in film and media studies and is engaged with in this Special Issue, as objectivity is a highly contested subject in the discipline. The history of film theory is littered with celebrations of and challenges to objectivity as an approach that is either ontological (and rooted in the apparatus) or aesthetic (and rooted in cinematic style). André Bazin celebrates cinema as 'objectivity in time', realized when formal choices exploit cinema's ontological potential to create close, deep connections between spectators and objects in the real world. On the other hand, scholars of what has come to be known as 'Apparatus Theory' insisted that the camera and the realist aesthetics characteristic of the dominant cinema project a vision that is presuppositionless, transparent, and that supports the centrality of the transcendental subject. In turn, they sustain dominant class, gender, racial, and ethnic positions that masquerade as natural, as emanating 'objectively' from the historical world.

Documentaries, particularly those employing realist aesthetics, were especially vulnerable to such critiques. Nichols notes that objectivity in documentary is related to but distinct from the principles undergirding scientific research. In science, he argues, objectivity centers on the reproducibility of the experiment and the resulting data—the scientist's presence cannot have an effect. In documentary, however, objectivity manifests rhetorically in support of truth claims and to deny the partiality of the filmmaker, whose 'experiment' can never be fully re-created (Nichols, 1991: 30). Winston aims to debunk this rhetorical move, specifically by calling into question how American direct cinema filmmakers responded to criticisms of their claims of objectivity.[2]

> The films are claimed as objective evidence of the subjective experience of the filmmaker–but so sensitive is the filmmaker and so accurate is the recording of his experience on film that the audience can supposedly act as judge of the original event. The result is that this rhetorical strand, 'objectivity is bullshit', still in effect makes the same implicit cultural appeal to photography's scientific heritage as does the other strand of direct cinema's practitioners' 'window on what's happening' rhetoric. (Winston, 1995: 162)

Here, Winston perceptively isolates a distinction between two different claims of objectivity, marking the shift in the foundations of its epistemological justification. Instead of objectivity emanating from the mechanical observation and registration of social actors who learn to act as they would otherwise in the presence of cameras and a crew, objectivity claims rely on recourse to trained experts capable of discerning patterns of behavior and presenting those metonymically to audiences. This corresponds to the shift from 'mechanical objectivity' to 'trained judgment' that Daston and Galison (2007: 313) identify as occurring over the course of the middle of the 20th century. Each modification recognizes a 'corrosion of faith in an objectivity vouchsafed by an aspiration to an automatic transfer from [in the case of science] object to paper' or object to screen. And each answers this doubt by asserting a newfound faith in the professional training and intuitive skills of its practitioners. Direct cinema filmmakers' sensitivity is achieved after years of training, is supported by cinema's basis in photography, and allows practititoners to identify or highlight patterns of behavior that are revealing (of the experience of being there) and trustworthy (that does not impose a vision on the world but allows viewers to discover it). Scientists' training and experience likewise allows them to identify or highlight 'complex families of visible phenomena', which trained judgment could 'smooth, refine or classify'. Moreover, the cultivation and celebration of a 'sight' capable of synthesizing, grasping, and highlighting relationships of various kinds did not reside in or emerge solely from the expert. These experts embraced the new technological instruments that served as crucial support of these judgments. And the legibility of these judgments counted on audiences' increasing ability to read the language of the world as it was realized in the moving images and sound of direct cinema or the still image atlases of scientists.

Whereas Winston concludes his critique by arguing that the direct cinema filmmakers' new discursive stance remains cloaked in familiar notions of scientificity, the contributors to this issue take a different tack. They refuse to conceive of change in visions of knowledge as 'the oscillations of a pendulum between two fixed extremes in a two-dimensional pole' (Daston and Galison, 2007: 371). They argue that shifting methods, goals, and personae *matter*. They affirm multiplicity and contestation as the order of the day, redressing assertions made by documentary scholars about the problems of importing a singular scientific ethos with a singular, transparent mode of communication. Instead, they make these different approaches

productive by locating them historically in their social and technological networks.

De-stabilizing Referents

One of the primary ways these articles affirm the variety of documentary's crossings with science is by emphasizing the *processes* of production, articulating the terrain of the 'experimental' in the interstices of scientific image-making and documentary filmmaking. Here 'experiment' incorporates both its scientific and cinematic meanings. Hanna Rose Shell (2012, this issue) translates the tenets of the scientific research film into what she calls a 'ciné-historical experiment'. Shell's article is a critical and demonstrative exploration of an emergent genre of scientific, historical, and academic knowledge production, one in which the image becomes the basis for the communication of history and scientific experiment. For Shell, privileging the image brings to the fore issues that are often spurned in traditional writing, such as 'the relationship between scientific process and graphical registration … the embodied experience of the scientific investigator in relation to that of filmmaker and viewer, and … the distances and resonances between past and present'. In both her article and film, Shell is uniquely attendant to the contingent and affective experiences of scientific observation. By locating the centrality of observation to the scientific (and documentary image-making) process, Shell articulates it in its multi-dimensionality: as a labor, a pleasure, and a performance.

The terms and implications of the 'experiment' are never taken as givens, but are rigorously located, historically and theoretically, in all the articles. Orit Halpern (2012, this issue) addresses this issue directly, describing the historical conjuncture between post-Second World War experiments in communication sciences and contemporary work on design and aesthetics to chart emergent forms of attention and cognition. For Halpern, Gyorgy Kepes's incorporation of cybernetic theory into his design pedagogy and Charles and Ray Eames's combination of communication, cognitive and behavioral sciences with design principles offer a foundation for understanding our current engagements with screens. These efforts to transform the relationship between image, perception, and knowledge register a shift in concern from documentation, representation, and archiving 'to a new set of investments in process, communication, and circulation now encoded into built environments, machines, and attention spans'. Halpern's argument offers not just a fascinating intellectual history of the relationship between non-fiction image production and pedagogy – one that runs counter to the narrative about documentary's increasing emphasis on unimpeded documentation in the post-Second World War period – it provides (as does Shell) a reminder that emergent forms of digital documentary are contingent on the relationship between the interface and the earlier representational and storage practices upon which they rest.

Experiment, in all of these cases, evokes process and possibility, highlighting the eruption of the contingent so as to 'formulate both a theory and a practice of visual, performative history' (Shell, 2012, this issue). While some of the articles address work that makes this explicit (Shell, Halpern, Cahill), others critically intervene by pointing to the constructedness of scientific facts and the effort that goes into the *figuration* of scientific knowledge (Landecker, Ostherr). As Scott Curtis (2004: 220) argues, one of the most important issues shared by film studies and medical films (and I think we can include in this comparison the larger category of science films) is the concern with the 'creation and interpretation of "legible" images'. Paying attention to the strategic management of detail allows one to refocus thinking on documentary from a concern solely with representation to include the array of labor practices that goes into stabilizing facts and making them legible (or, in the case of Cahill's article, working against that goal by emphasizing the critical ambivalence Painlevé felt towards educational realism as a broadly guiding principle).

Science and Technology Studies (and actor-network theory in particular) are uniquely applicable to documentary studies because they developed a set of tools aimed to address precisely this issue. Bruno Latour (see, e.g., 1987, 1999), Michel Callon (see, e.g. 1986), John Law (see, e.g., 1982) and others insist on the profound relationality of everyone and everything. Entities, they argue, only have qualities, attributes or form as a result of their relationships with other entities. They apply this insight ruthlessly to everything involved in producing scientific facts, not limiting this to language and the play of signifiers. Actor-network theory thus provides a way of imagining documentary pre-production, production, post-production, distribution, and exhibition practices as an integrated network for circulating knowledge. Bruno Latour's work on soil samples in the Brazilian rain forest, for example, demonstrates how stabilizing facts and making them legible is an achievement of referentiality rather than an inevitable result of production processes. He illustrates how indexicality is produced and sustained in circulation by scientists laboring to maintain the stability of indexical referents as they move from context to context. As the scientists bring the soil samples and their descriptions into each new context, they attempt to ensure that the referents can be traced through each context back to the original location in the Brazilian forest. In analyzing this example, Latour (1999: 76) argues that scientists construct 'reversible indexicalities', claiming that for signs to be able to represent truth in a scientific network, the referents must exist as a stable chain that points in both directions as the referents move between contexts. He argues: 'For this network to begin to lie – for it to cease to refer – it is sufficient to *interrupt* its expansion at either end, to stop providing for it, to suspend its funding, or to break it at any other point' (emphasis in original). In short, what is important for Latour is recognizing and identifying the labor that goes into constructing reversible indexicalities.[3]

Scholars of documentary likewise have a history of analyzing how various (and shifting) semiotic strategies work to buttress the truth claims of a given

film or set of films. And indexicality is acknowledged as a crucial (and I would argue, ideological) support for such assertions – the material connection between the photographic sign projected onscreen and the object in the real world serving as guarantor of truth. But is the indexicality of film studies the indexicality to which Latour refers? And if not, is there another way of theorizing indexicality that accounts for: first, the breadth of CS Peirce's second class of signs; second, the diversity of ways these science films reference, speak, and listen to the real world; and, third, the changing media landscape? A model of indexicality that accounts for its definition as trace *and* as deixis or shifter speaks to the kind of urgency we see in documentary and science films. In this way, indexicality can retain its critical potential and currency by speaking to the kind of work artists and scientists produce while accounting for their (and their audiences') increasing understanding of the labor that goes into producing truth and referencing the real.

Indexicality as trace and deixis

In the second half of the 19th century, CS Peirce developed a complex taxonomy of signs that sought to account for what he understood as the dynamism of both speech and interpretation. If Ferdinand de Saussure[4] was primarily concerned with locating the proper domain of synchronic linguistics, Peirce 'opens semiotics to the world, through the object, and to ideology, through the interpretant' (Hanks, 1996: 44). Whereas Saussure emphasizes the arbitrariness of the link between signifier and signified, Peirce offers a typology of relations which identifies the ways in which the sign can stand for an object. The index, his second class of signs, is likely the most multifaceted class of signs, distinguished by the way it speaks to the singularity of the referenced object, and serving primarily as an assurance of its existence rather than testifying to the nature or content of the object. On the one hand, indices specify signs that are physically modified by their objects (footprints, masks, weathervanes) so that they share a physical *connection* to that object. On the other hand, they refer to the deixis or 'shifter' ('this', 'here', 'now', 'I', 'you'), Roman Jakobson's term for the category of linguistic signs that signifies *spatio-temporal presence* even as it remains hollow (i.e. it is only meaningful once the referent is supplied). In fact, Peirce identifies this kind of sign as the archetypal example of the index.

The definition of the index as trace has been thought applicable to photography, whereby the photograph has an existential bond with an object that leaves its imprint on light-sensitive material ('they are in certain respects exactly like the objects they represent' (Peirce, 1932: 159). Photographs also merge index with icon (and often symbol), their images resembling the objects themselves. But in so doing, the image's iconicity relies on the index, depending upon the fact that it was 'physically forced to correspond point by point to nature', in this case, the object photographed. Cinema's basis in photography and projection sustains and even extends this claim;

light carries the embedded information directly to a screen (which viewers then engage), thus maintaining this physical connection.[5]

If the index as trace upholds an alignment with iconicity, index as deixis partakes of the symbolic order. It emphasizes not just existence but presence and immediacy, underscoring the contingency of the linguistic articulation. Whereas the index as trace has a rich history of elaboration in film studies, the index as deixis has received considerably less consideration. But the deixis's assertion of 'this' or 'here' speaks to the direction of attentivity so central to the management of the cinematic gaze.[6] Christian Metz (1974) describes how the image *actualizes* a real for the viewer, a quality he identifies as an 'index of actualization'. For example, 'a close-up of a revolver does not mean "revolver" (a purely lexical unit), but … "Here is a revolver!"' For Metz, even a straightforward cinematic image corresponds to a sentence rather than a word. It does so less by the 'quantity of its meaning … than by its *assertive* status' (p. 67, emphasis added). Whereas Metz's conception emphasizes the present moment and the index's power as a cultural and semiotic force, it is interesting to note that Metz uses precisely a presentational sentence containing a deictic ('Here is …') to illustrate this 'assertive' status.[7] If the index as trace speaks to the historicity of the photographic image, the index as deixis marks the enunciative moment itself as critical to the establishment of spatial and temporal context. In this way, it speaks to the multiple temporalities these different indexical claims instantiate.

This idea of deictic index as indicator and as symbol is also realized in the way in which, in addition to the 'index of actualization', the deictic brings to the fore the limit of the frame itself. As Mary Ann Doane (2007b: 138–140) demonstrates, the deictic demarcates the borders of cinematic space. In so doing, it isolates a space for aesthetics, in turn creating expectations in viewers of aesthetic activity. This combination of various indexical claims and expectations is what drives Doane's argument that the index is today potentially '*the* primary indicator of cinematic specificity' (p. 129, emphasis in original). It is the dialectic of the index as trace and index as deictic that so powerfully sustains it as a force in cinema. The index as trace or imprint on a photograph *endures*, testifying to the reality of its existence at some point in time. The index as deixis actualized through cinematic strategies marks the *temporal* moment of actualizing the real, testifying to the immediacy of the viewing experience. And the index as deixis that demarcates the borders of the frame highlights the '*hereness*' or '*thereness*' of space, testifying to cinematic spatiality. This combination produces an assurance and intensity, explaining the index's theoretical value for conceiving cinematic ontology, while still accounting for the dynamics of the interpretive moment.

Thirty years ago, in an early extended consideration of the importance of the index for artistic representation, Rosalind Krauss (1977a) argued that the photographic logic of the index is the key to the uniqueness of 1970s abstract art. It is not just 'the heightened presence of the photograph itself that is significant. Rather it is the photograph combined with the *explicit terms of the index*' that distinguishes this work (p. 78, emphasis added). Krauss

points to the readymades of Marcel Duchamp as a model for this project. She writes, 'the readymade's parallel with the photograph is established by its process of production [emphasizing the least possible connection between the artist and the material itself]. It is about the physical transposition of an object from the continuum of reality into the fixed condition of the art-image by a moment of isolation, or selection. And in this process, it also recalls the function of the shifter' (p. 78). For Krauss, the index is a force that works to transfer an object from reality into different contexts (even alternative or multimedia contexts), while maintaining its link to the precedent reality. It depends upon the deictic aspect for its mobility – a mobility which, because its meaning is realized in the moment of the actualization of the shifter, highlights the performative, processual nature of the work. In this way, it becomes a force that can be activated both explicitly and implicitly.

This emphasis on experiment, on process, and on the desire to sustain a link with material reality despite the barriers to communicating knowledge corresponds with this issue's concerns. Like the work Krauss discusses, the efforts of scientists and filmmakers to overcome the problems of scale (micro or macro) or health are at times explicit, reflexively calling attention to the challenge of scientific communication. At other times, they are less so. But for all of the articles, the challenge of communicating scientific knowledge is visible on the surface of the films themselves, whether that process is an issue of critical contemplation or not. And like the artists Krauss considers, these efforts often necessitate various photographic and even non-photographic means. This notion of the index as force can help explain the logic behind these various multimedia and transmedia strategies.

There are two challenges to scientific communication that recur in the issue's articles: first, the problem of isolating and clarifying detail so as to create a consensus object for discussion; and, second, the problem of accessing life processes in real time so that the 'aliveness' of the body is sensible by those engaging the images. Scott Curtis (2004: 221) argues that this representational and hermeneutic dilemma is at the very heart of medicine, since 'the human body is oppugnantly *alive*, [yet] frustratingly resistant to contemplation, study, and interpretation' (emphasis in original). Analysis itself is thought to fix, and thus 'kill' the object of study. Makers of scientific films have sought to overcome these barriers through (among others) an array of animation strategies and new technologies that seek to make visible micro or macro processes. Conceiving of indexicality as force informed simultaneously by the logic of the trace and the logic of the deictic allows us to understand how isolation and clarification were wedded to animation in a way that was not in opposition to the index but that partook of its promise.

The Index as Alive

From their inception, documentary films and science films have incorporated animation; indeed, the first photographic moving images can perhaps be

best understood *as* animations, as indicated by the frequent epithet for early cinema, 'animated photography'. Beyond this initial period, the documentary has called upon animation's illustrative capacity as well as the playfulness that came to be associated with the animated cartoon. Documentary examples include Dziga Vertov's illustration of how to install a radio tower in *Kino-Pravda #23* (Vertov, 1925) as well as his playful *Soviet Toys* (Vertov, 1924); Frank Capra's politically-loaded pincers narrating the Battle of Poland in his Second World War *Why We Fight* series (Capra, 1943); and Michael Moore's (alleged) plagiarism of *South Park* in his montage on the interrelated history of racism and gun violence in the US in *Bowling for Columbine* (Moore, 2002). And contemporary examples abound, including Ari Folman's Academy-Award nominated *Waltz with Bashir* (2008), Brett Morgen's *Chicago 10* (2007), and Vincent Paronnaud's and Marjane Satrapi's *Persepolis* (2007). Concomitantly, documentary scholars have begun increasingly to theorize the role of animation within these films, locating its textual meanings and pleasures in relation to that of live action footage as well as differentiating various types of animation techniques and strategies.[8] But, for many, the animated image is non-indexical in that it does not provide a promise of a trace to the real world.

There are two problems with this line of thinking. First, as Doane (2007b: 148–149, note 3) points out, these arguments hold only if indexicality is aligned with a traditional understanding of realism or only seen as applicable to referents not sullied by human contact. But, even in such cases, the photographed image as indexical trace remains in that the animated graphic image, clay figures, or actors who are eventually pixilated are themselves often (though surely not always) photographed by the camera lens. Second, a more comprehensive notion of Peircean semiotics that accounts for the index as trace and as deixis challenges the exclusion of animation by allowing us to mark certain animation strategies as insisting on 'co-presence', or 'thereness', or even on 'nowness' and therefore partaking of the indexical logic. At the same time, it encourages the identification of animation strategies that work to distinguish the animated material from the natural world, directing its meaningfulness toward other dimensions.

Animation has commonly been used in science films as a method of managing detail. The legibility of the scientific image has long depended on effective image management, which creates the conditions for pedagogy. Photography's wealth of detail provided a new dimension to the problem of making images work for science. As Kirsten Ostherr's article (2012, this issue) demonstrates, filmmakers working on science have a long history of turning to animation as a potential solution to the problem of communicating medical knowledge. Ostherr argues that the collaboration between the American College of Surgeons (ACS) and Eastman Kodak in the 1920s reveals that animation was used extensively and unapologetically, becoming, in fact, 'the privileged form of visual presentation for documentary science films'. Rather than a degraded formal strategy in relation to live action images, animation became an invaluable tool for visualizing the interiors of living

bodies. Ostherr's article highlights not just the centrality of moving images to the practice of medicine but explains how a combination of visualization techniques constructed medical truth, identified (and trained) the object of analysis, and newly shaped the medical imagination. In so doing, she provides an important reminder that documentary truth has never been exclusively associated with live action images, especially when education is one of the foremost pursuits.

Animation's method of illustration or visual pointing – calling attention to certain details while bracketing others – is one of the foremost means by which the pedagogical function occurs. This pointing and isolating subtend the logic of connection, of contiguity, that defines the terms of the deictic. Krauss (1977b) is once again instructive for thinking about how the deictic as cultural logic and semiotic force crosses media boundaries. After arguing that the unique structure of Lucio Pozzi's two-color painted panel installation creates a sense of *transfer* from the natural world to the painting, she makes a bolder claim about how the terms of the index drive the logic of the painting. She writes:

> The painting as a whole functions to point to the natural continuum, the way the word *this* accompanied by a pointing gesture isolates a piece of the real world and fills itself with a meaning by becoming, for that moment, the transitory label of a natural event. (p. 64)

By systematically transforming the terms of the pictorial in favor of photographic conventions, Pozzi's piece calls upon the force of the index outside the photographic medium.

My point is not that all examples of animation in science films can be productively thought of in terms of indexicality. But the process of isolation and illustration common to animation *can* be textually and extra-textually mobilized to point to the natural continuum. And, to be sure, these filmmakers and their collaborators often have motivation to do so. Scholars must ask what kind of labor goes into establishing the framework within which these connections are built while analyzing the kinds of connections that are posited.

William Hanks (1996: 178–179) breaks down indexical–referential terms categorically. He distinguishes, for example, locative deictics concerned with spatial inclusion and exclusion from participant deictics concerned with address from temporal deictics – as well as the subtle divisions within the various categories.[9] Elsewhere, he develops a contrast between the figure (the discrete, singular aspect of deictic reference) and the ground (the diffuse, background upon which the referential figure is built) to help analyze the production of context (Hanks, 1992: 60–61). Hanks emphasizes the dynamic and productive aspects of the indexical ground, noting how it presupposes and entails specific interactive relations. Certainly, many of these categories will require modification so as to be applicable to a film-specific context.[10] But specifying the deictic expressions and doing so in

relation to promises of the physical trace will help us to distinguish among a multiplicity of animation strategies at work in science films, to stipulate the terms of the indexical relations they posit, and to locate those claims in more nuanced ways in relation to other footage types.

I want to conclude my discussion of indexicality by pointing to the example of live-cell imaging (the focus of Hannah Landecker's article in this issue), a mode of visualization that both speaks to and complicates the cinematic spatio-temporality commonly associated with indexicality. Live-cell imaging is a new technique of visualization that relies on the genetic modification of an organism to produce fluorescent luminosity. Combined with time-lapse techniques and digital mediation, live-cell imaging 'traces the life and movements of cells via the fluorescent labeling of their constituent molecules'. The importance of live-cell imaging for scientific research (and its connection with film theory) is its emphasis on time. It speaks to a dissatisfaction with the representation of genetic life through codification by re-animating the body at the molecular level, emphasizing the process of molecular events over tissue or organ structure. But live-cell imaging's promise of an unprecedented capture of or access to life itself demonstrates the messiness of the relation between scientists' commitment to fidelity to nature (here at the molecular level) and a corresponding aesthetic approach. What I mean is that live-cell imaging demonstrates that a commitment to fidelity to nature need not be realized in a realist aesthetic that asserts the passivity of the natural world; or at least that it need not do so in ways that remain vulnerable to common criticisms of scientific and filmic realism. Rather, it opens the door to a new conception of realism that accounts for the perceptive criticisms and yet offers new possibilities for connection between all actants in the natural and historical world.

Peter Wollen was the first to suggest that André Bazin's understanding of the image aligned with Peirce's description of the index. Wollen (1972: 131) argued that Bazinian realism adheres to 'fidelity to nature' and 'develops logically from an aesthetic which stresses the passivity of the natural world rather than the agency of the human mind'. Live-cell imaging, in Landecker's account, does not assume a passive natural world directly reflected in an apparatus. Instead, it emphasizes the contingencies of life processes, recognizing that *visualizing* these processes is only possible because of the steps taken by scientists. By transforming the genetic code in such a way that the organism itself produces the fluorescent protein (producing 'one of the conditions of its own image', Landecker, 2012, this issue), scientists create a situation in which the passivity of a stable world captured automatically by an apparatus and observed neutrally by viewers is unthinkable. These molecular processes are recognized as increasingly contingent, not pre-determined but acting according to an ever-shifting set of rules and guidelines that are (clearly in this case) affected by the visualizing process itself.

It is not just the active relation between life and visualization processes but also the obsessive willfulness of the scientist that make the idea of

indexicality so central. It is the 'aliveness' – watching molecular reality or fish locomotion, for example, in time – that underlies the excitement. Indexicality as a connecting force serves as a means of overcoming the dissatisfaction with the 'lifeless representation of life' so familiar to scientists' earlier experiences with still images and recent experiences with moving images of molecular life. The willful activity of the scientist to overcome such barriers infuses the material with force. Such a position harkens back to Philip Rosen's (2001) critique of earlier conceptions of Bazinian ontology. Rosen challenges Wollen's emphasis on passivity, arguing, 'it is precisely the activity and desire of the subject – "our *obsession* with realism" – that makes indexicality the crucial aspect of the cinematic image for Bazin' (p. 18, emphasis in original).[11] The work by Rosen and others to transform the terms of Bazin's realist aesthetics and ontology,[12] along with alternative conceptions of realism in science studies, have the potential to inform new conceptions of documentary realism and, in turn, to reconfigure the relationship between indexicality and realism.

Realism and Relativism

Mary Ann Doane and Jane Gaines each regret the presumptive link between indexicality and realism. For Doane (2007a: 4), the cinematic index's iconic aspects have prompted associations with a realism that claims to build a mimetic copy of the world. In so doing, such alignments deny the trace and performative aspects of the index, which 'reference a real without realism'. Whereas Doane promotes a conception of indexicality without realism, Gaines's (1999) work on documentary realism urges a dissociation of indexicality and realism by transforming the terms of the mimetic relation in the hopes of salvaging the political uses of realism (p. 95). Instead of an emphasis on the mimetic relation between image and world, she privileges the relation between image onscreen and viewing body (pp. 88–89). For Gaines, the power of certain politically-radical realist documentary films is their potential to physically and automatically *move* audiences to feel and to act like the bodies onscreen. Even though she addresses films made in the realist tradition, Gaines's account crucially relies on a notion of trace (in this case a 'magical' transfer from body onscreen to body in audience) and performance (the emphasis on the moment of actualization). In this way she articulates a realism undergirded by an indexical promise that need not reinforce the stability and centrality of the singular subject. It neither necessarily asserts a direct relation between the image and the world, nor demands a search for absolute certainty about the world. This conception of a realism shorn of naiveté and committed to establishing *connections* resonates with an actor-network theory notion of realism.[13] A version of realism informed by actor-network theory embraces *relativism,* seeking to articulate the relations between actants in the world. It is a process of making these connections visible, sensible, knowable, and immediate without denying that the constructive process takes place. It recognizes the connections between things as an *experience* of a relation, an encounter

between people, filmmaker and objects, between viewer, sounds, and images. In that way, realism perhaps relies on a tacking back and forth between proximities, pushing things away to bring them closer.

In his critique of the documentary tradition's purported 'claim on the real', Brian Winston (1995) mobilizes Latour's notion of the 'obstinate dissenter', a figure who refuses to believe a result reported in a scientific paper and who thus becomes a vessel for Latour's breakdown of the scientific community's construction of facts. Winston links the visual set of inscriptions produced by scientific instruments and the narrating voice of the scientific paper to documentary's own production of facts through the visual inscription of the camera and the narrating 'voice' of the filmmaker. The problem, for Winston, is that the camera has long been considered an inscription device akin to a scientific tool, automatically registering the trace of the real world. While actor-network theorists would likely support this critique of the 'automatic rendering of reality', they would challenge Winston's implications. Winston concludes his book by arguing that what is 'most important' is that the audience understands 'that what is on offer is indeed a *truly subjective* interaction with the world' (emphasis in original). Once documentary becomes 'unburdened by objectivity and actuality' a true creative treatment can emerge (p. 254). However, for actor-network theorists, this total emphasis on the subjectivity of the filmmaker is not just a recognition of the social construction of facts, it serves to disconnect humans from the rest of the world, irrevocably dividing the social from the natural. Latour (1987: 78–79) offers an alternative position:

> We have taken science for realist painting, imagining that it made an exact copy of the world. The sciences do something else entirely – paintings, too, for that matter. Through successive stages they link us to an aligned, transformed, constructed world. We forfeit resemblance, in this model, but there is compensation: by pointing with our index fingers to features of an entry printed in an atlas, we can, through a series of uniformly discontinuous transformations, link ourselves to Boa Vista. Let us rejoice in this long chain of transformations, this potentially endless sequence of mediators … I can never verify the resemblance between my mind and the world, but I can, if I pay the price, *extend* the chain of transformations wherever verified reference circulates through constant substitutions. Is this 'deambulatory' philosophy of science not more realist, and certainly more *realistic,* than the old settlement? (emphasis in original)

In combination with recent work by film scholars on realism, Latour here offers a ground upon which a new conception of non-fiction film realism can be built. It is a realism that aims to offer epistemological, political, and historical connections, locating both maker and viewer in the chain of mediations. And it both relies on and accounts for the ideological underpinnings of indexicality as 'a concept, an expectation, and a cultural and semiotic force' (Doane, 2007a: 6). To be sure, there is still significant

critical and theoretical work to be done in elaborating a non-fiction film realism that relies on insights from film scholars and science studies scholars. But perhaps this approach is a way of unthinking the dominant legacy of Italian Neorealism in such a way that we can begin to re-imagine a figure like Sergei Eisenstein the way he himself imagined his work – as drawing connections, material and spiritual, between things.

Art, Science, and the Cultivation of Epistemania

> The difference between 'art film' and 'science film', however useful otherwise, is not relevant in this case, as we are as yet unclear about where 'art' begins and 'science' ends. (Filmliga Program)[14]

The articles in this issue of *journal of visual culture*, like my discussion above, aim to contribute to efforts to nuance notions of non-fiction film semiosis, in part by pushing beyond the limitations of that framework. But these articles also account for the *affective* aspect of films that address scientific matters, reminding us that, in Barthesian terms, scientific image-making is not all *studium* but is ripe with *punctum*. Malin Wahlberg (2006) has called attention to the interrelation of science films and experimental documentary in the 1920s, arguing that they were both centrally fascinated with 'space–time abstraction and visualized rhythm', exploring how 'the magic of these screen events resides in the play with documentation and abstraction of a pro-filmic realm' (p. 274).[15] The contributors to this issue build upon and extend the triangular relationship among science, documentary, and the avant-garde.

Oliver Gaycken (2012, this issue) explores the relationship among realism, the avant-garde, and the science film in another direction – that of aesthetic beauty. The beauty of the science film, for its proponents, is a specific kind. It is paradoxically achieved by eliminating artistic intentionality and challenging traditional notions of aesthetic beauty. Examining an underexplored element of Andre Bazin's cinephilia, Gaycken calls attention to an alternative critical and cinematic aesthetic conception, rooted in surrealism, that celebrates the accidental, the contingent, the chance discoveries occasioned by the film camera's automatism. Gaycken turns to a contemporary compilation film – Gustav Deutsch's *Film ist.* – as a remarkable example of the long-standing affinities between the science film and the avant-garde. For Gaycken, this approach defines the science film (and, in turn, the documentary) less in ontological terms and more by 'a cluster of aesthetic effects that requires thinking across modes, from documentary to narrative fiction films and beyond' (Gaycken, 313). Concomitantly, it highlights a mode of attention that rewards viewers for apprehending secret treasures beyond the documentary filmmaker's or science filmmaker's intended meaning.

James Cahill (2012) offers a playful contrast to Gaycken's tracking of a discourse of finding 'hidden treasures' with his elaboration of the scientific documentary's 'forgetting function', a critical aspect that urges viewers

to unlearn what they have been taught explicitly or have been trained to expect. Cahill's work on the French biological/wildlife/para-Surrealist filmmaker Jean Painlevé, like all of the issue's contributions, speaks to the range of educational opportunities and challenges that science films and documentary films have historically posed. Painlevé's approach can be understood as a kind of counter-pedagogy, a challenge to the French educational system's embrace of a 'realist' pedagogical model that relied upon the development and shaping of students' senses into a 'common sense'. The lesson Painlevé offers, Cahill argues, is the possibility of presenting precise, rigorous, and concrete facts simultaneously with abstract concepts and sensuous perception. The 'romantic friction' of science and surrealism that Cahill elucidates reveals an impulse underlying the pleasure our contributors variously describe, one driven less by a dry epistephilia and more akin to the 'madness and intoxication' of an *epistemania* (p. 273).

By paying close attention to the processes and aesthetics of experimentation, the contributors to this issue of the *journal of visual culture* aver the strong aesthetic and philosophical intent, careful editing, and distinct narrative structures that shape the power of these works. It is our belief that detailed accounts of the wide range of practices and audiences that the term 'scientific' contains, which range from the research film produced for a professional audience to the popular scientific film produced for a general audience, can transform characterizations of a 'scientific' approach to documentary from one of limitation to one of possibility.

Notes

1. To be sure, we could imagine films about scientific matters being included in some of these sub-categories. I note its absence on account of the fact that it is not mentioned despite a wide range of category types – anti-government (thematic), independently-produced (sponsorship), and compilation films (structural–methodological).
2. Certainly part of this connection between objectivity and documentary relies on documentary's connections with journalism, which, in the US especially, maintains a tradition of objectivity as a core value (see Ward, 2006, and Kaplan, 2002).
3. For a fuller examination of the usefulness of an ANT approach for thinking about documentary, see Gershon and Malitsky (2010).
4. Saussure is the other (though surely not the only) major linguist that scholars of cinema have turned to for foundations in theorizing film language.
5. For a recent reconsideration of indexicality as a theoretically useful tool in understanding cinematic ontology see the special issue of *differences* 18(1), ed. Mary Ann Doane.
6. For a more extended consideration of the cinematic index as deictic and its relation to index as trace, see Doane (2007b: especially pp.135–140).
7. It strikes me that theorizations of deixis have become increasingly cinematic in their thought. Although Hanks's formulations do not directly speak to the uniqueness of cinematic temporality, his recent work on the 'deictic field' does seem to open up space for translation so as to be applicable to cinema.
8. The first extended consideration of the issue is Honess-Roe (2009). For an earlier overview, see Strøm (2003).

9. For analyses of the shifting referents of deictic expressions as the relationship between context and utterance changes, see Goffman (1974, 1981); Hanks (1990); and Volosinov (1973[1929]). For an extensive analysis of the properties of shifters and their relevance to language organization, see Silverstein (1976, 1985). And for a rethinking of deixis that integrates human interaction and language structure, see Hanks (1996).
10. See Malitsky (2010) for an example of its applicability to Soviet photographic-based work in the late 1920s and early 1930s.
11. Rosen (2001) directly engages part of the Wollen quotation I cite here.
12. In addition to Rosen (2001), see Morgan (2006) and Gunning (2007).
13. I mean to be very provisional in asserting a *resonance* here and not an alliance. Gaines's defense of the poststructuralist critique of realism is not embraced by actor-network theorists. Latour, for one, categorizes the humanist position as that of the 'brain-in-a-vat', a requirement that a mind have *absolute certainty* about anything from the outside world in order to accept it as true. In his view, this led to people tenuously gazing at a world from the inside out, removed, and in constant fear of losing reality, a view his version of realism seeks to challenge.
14. This program is available at the Amsterdam Film Museum site: http://www.polderdocumentaries.nl/eng/text/kristallen-eng.htm. Wahlberg (2006: 287) quotes from it more extensively in her article on JC Mol.
15. Nichols (2001) argues that the 1920s was when documentary first became identifiable as a filmmaking genre itself, emerging through a combination of photographic realism, narrative innovations, modernist practices, and rhetorical strategies.

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