22
Digital Materiality

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Paul Erickson once argued that book historians "are poised to make tremendous contributions to our understanding of new electronic media" (Erickson, 2003:110). An awareness that communication is always already a mediated experience combined with the skills of forensic analysis and bibliographic imagination are as relevant to books as to any other material form, including electronic records. At the heart of the critical enterprise is an understanding of digital materiality, not framed as the intangibility of cyberspace using the superficial distinction between physical, surrogate, and virtual, but as the palpable bits and bytes of electronic hardware and software that are ubiquitous, that leave traces, and that can be read as evidence of the creation, dissemination, reception, and preservation of these new communication forms. In this era of digital incunabula, physical ("hard") and electronic ("soft") publications coexist, often in hybrid forms. Mark Z. Danielewski's *House of Leaves* (2000) and *Only Revolutions* (2006) bridge the worlds of print and digital culture and construct highly interactive, self-reflexive works. William Gibson's early electronic text *Agrippa* (1992) performs its materiality as both a computer disk and a limited-edition artist's book: on screen, the encrypted 300-line poetic codework self-erases once read; the book version's photosensitized pages fade upon exposure to light. This chapter explores the concept of digital materiality and how it is captured in metadata, in interfaces, in time and date-stamped information processing, and in the multivariate interactions of users and forms in the contemporary multiverse.

In his discussion of the Giller Prize winning novel, *The Sentimentalists*, digital humanist, book historian, and media archaeographer Alan Galey (2012) posed an ostensibly simple question: what is the difference between a fine-press limited-edition work, a mass-market paperback, and an e-book? At first glance the answer might

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reside in the obvious distinction between the physical and the digital, the material and the virtual: one is an exercise in extreme physical creation from hand-setting metal types to hand-printing formes on dampened hand-made paper, to hand-binding the final product; the other two are manufactured from digital files, the commercial paperback digitally printed on machine-made paper and machine-bound, the e-book version encoded and delivered via proprietary software to, in this case, a Kobo reading device. By focusing on the bibliographic codes embodied in the title page, type, and epigraphs, however, Galey demonstrated that not only is contemporary publishing always already digital, but that the very materiality of the digital is exposed through deliberate acts of linguistic transgression: exposing and reading computer code; identifying anomalies in metadata; breaching the security walls of Kobo's digital rights management system. New media forensics, part of the digital humanists' intellectual toolkit, depends on recognizing the fundamental materiality of digital forms, extracting evidence of its existence, and interpreting its individual, unique manifestations.

Until scientists identified the nanoscale as the precise threshold between the material and the immaterial (Kirschenbaum, 2008:2), cyberspace and its world of electronic bits and bytes was popularly construed as intangible, invisible, ephemeral, unstable, and virtual. The capacity for human intervention was deemed magical and the affordances of digital objects were considered mysterious, arcane, and open only to the technologically initiated. This rhetoric contrasted sharply with that of the physical world, whose tangible, fungible, visible existence adhered to the normal, observable laws of traditional physics and remained both predictable and dependable. Since the early 2000s, however, the idea that digital objects should be reconceptualized as material, rather than virtual, has been the subject of considerable scholarly investigation in the humanities (McGann, 2001; Hayles, 2002; Drucker, 2003; Lavagnino *et al*., 2007); it has also attracted attention in both the social sciences (Hindmarsh *et al*., 2006; Hand, 2008) and in information science (Orlikowski, 2006; Leonardi, 2010). Scholars increasingly acknowledge that digital materiality, whether of digitized or born-digital objects, is not a contradiction in terms, but rather, a phrase that succinctly encapsulates a process of meaning making and knowledge production that emphasizes technology-in-practice rather than a technological artifact.

Textual scholarship, electronic editing, and new-media historiography have all generated substantial and significant discussions about the relationship between print and digital forms, the analog–digital continuum, and digital materiality. From the prescient work of D.F. McKenzie (1986/1999, 2002) who posited a sociology of texts that embraced all communication media, including the digital, to Jerome McGann's concept of the "socialization of texts" (1991) that underwrites current discussions of the social edition (Siemens *et al*., 2010), and from Johanna Drucker's early research on artists' books, visible typography, and graphic forms (1994, 2003), to Alan Liu's (1994) problematization of digital media's claims to transcendence in the face of encoding practices and the imperatives of network transmission, materiality is configured as part of a "sustainable dialectic" (Drucker, 1994:43) whose phenomenological existence is inseparable from the process of interpretation. Lisa Gitelman's (2006) examination of "new" media from the early eighteenth century to the present day enriches our understanding of the interpenetration of analog and digital forms (Gitelman, 2006:95–6). N. Katherine Hayles (2012) continues to respond provocatively to the

challenges and opportunities inherent in positing this communication continuum, understanding human-techno hybridity, and exploring technogenesis, the coevolution of the human and technological. Book historian Roger Chartier reminds us that material instantiation is also an act of engagement: "reading is not a solely abstract intellectual operation; it involves the body, is inscribed within a space, and implies a relationship to oneself or to others" (Chartier and Cavallo, 1999:4). Even across media forms, as Paul Eggert suggests, "whether the textual carrier be the physical page, a computational capacity, or the sound waves that transmit orally declaimed verse, there is always a material condition for the existence of text" (Eggert, 2005:428). Scholars of media archaeology and proponents of new materialism such as Wolfgang Ernst (2011) and Jussi Parikka (2012a, 2012b) also highlight the centrality of the material in their study of the hardware and software of culture.

In exploding the tactile fallacy of digital immateriality, Matthew Kirschenbaum (2008) distinguishes between two types of digital materiality: forensic and formal. Forensic materiality consists of the physical evidence of production, distribution, reception, and preservation which can be detected through the identification and analysis of various traces, residues, marks, and inscriptions visible to human sight or accessible through instrumentation. On the one hand, chips, touch screens, terminals, cables, keyboards, and mice are all capable of recording human and machine interactions. On the other hand, nanotechnology's magnetic-force microscopy can reveal the bit pattern cut into a computer disk and expose recoverable areas of corruption whether through chemical degradation of the physical substrate or multiple overwritings. Digital forensics is analogous to the activities of book historians and bibliographers working in the domain of manuscript and print artifacts who analyze, amongst other material manifestations, the physical characteristics of paper composition and manufacture, handwriting styles and inks, printmaking, illustration, and bookbinding techniques. Both embrace a kind of "crime scene investigation" process using extant material evidence and inductive reasoning to argue for patterns of textual transmission, licit or illicit interventions, or artifactual legacies of the publishing process. Galey's case study of *The Sentimentalists* which opens this chapter demonstrates how an analysis of the file names and formats for the Kobo e-book cover illustration were repurposed by the publisher from the digital file that generated the photopolymer which was handprinted in the original letterpress edition, thus complicating the simple binary of mutually exclusive print and digital forms.

Formal materiality engages with the architecture of digital media and their symbolic forms, whether the structure of individual software programs, embedded data standards and metadata encoding, or operating-system configurations. Like forensic materiality, there is always a physical manifestation, but whereas the forensic is focused on attributes, formal materiality concentrates on the digital environment which Kirschenbaum (2008) defines as "an abstract projection supported and sustained by its capacity to propagate the illusion (or call it a working model) of *immaterial* behavior: identification without ambiguity, transmission without loss, repetition without originality" (Kirschenbaum, 2008:11). Despite this illusion, existing (if hidden) content can be formally exposed using built-in functionality such as "reveal source," and "show header," or by deploying encryption keys; the existence of errors discloses the Achilles heel of an imperfect system in motion. For example, in determining why there was a

different ordering of epigraphs in the e-book version of *The Sentimentalists*, Galey drilled down to the SQL database driving the publication and discovered a coding transposition that delivered the wrong information and corrupted the logical sequence of the original text.

Johanna Drucker (2013) has recently proposed that two forms of materiality be added to the lexicon of forensic and formal: distributed and performative. Each of them usefully complements and extends Kirschenbaum's distinction and draws on a wide range of philosophies and approaches. Distributed materiality, based on the work of informatics and encryption specialist Jean-François Blanchette, relates to "the complex of interdependencies on which any digital artifact depends for its basic existence"; that is, the "co-dependent, layered contingencies on which the functions of drive, storage, software, hardware, systems, and networks depend" (Drucker, 2013: paras.21, 6). Performative materiality, drawn from studies in cognition, perception, reader-response, textual hermeneutics, and interface design, further emphasizes the functional dimension of materiality, its existence defined by and interdependent upon use, interactivity, process; that is, "what something *is* has to be understood in terms of what it *does*, how it works within machinic, systemic, and cultural domains" (Drucker, 2013: para 4). As Drucker explains:

> The many dimensions of performative materiality, then, touch on each layer of digital media – in an analysis of the co-dependencies and contingencies of the material substrate, in a description of the production of display from code through processing as a performative act, in the engagement of users with the generative experience of viewing, and in the mutability and reinscribability of files in the mutable substrate of digital technology. While such a description sounds like a characterization of the essential qualities of digital media, it is meant as a description of the ways these qualities are always operating within contingent fields, flows, and relations that reconstitute them. (Drucker, 2013: para.13)

Almost three decades after the launch of the World Wide Web, it is easy for us to recognize ubiquitous computer hardware such as smartphones, tablets, laptops, or e-readers to be as physical as chairs, desks, coffee mugs, or teacups. Even software and its users leave tangible, recoverable traces on hard drives, servers and in the so-called "cloud." Data structures and file formats are equally tangible and equally recoverable; we know that computer hackers are experts at both exposing the architecture of information and identifying the wormholes to dislodge and disrupt its systems. So while we can agree that the digital world is as full of stuff as the physical world, what if that stuff is only meaningful when it interacts with a sentient being, like ourselves? Many scholars, Drucker included, argue that materiality only exists in acts of perception, in performance, in use, in practice. As Paul Leonardi suggests in the context of information systems and organizational management:

> "material" would refer not to inherent properties of the artifact, but instead to the way that the artifact exists in relationship to the people who create and use it. These alternative, relational definitions move materiality "out of the artifact" and into the space of interaction between people and artifacts. No matter whether those artifacts are physical or digital, their "materiality" is determined, to a substantial degree, by when, how, and

> why they are used. These definitions imply that materiality is not a property of artifacts, but a product of the relationships between artifacts and the people who produce and consume them. (Leonardi, 2010)

In order for the instrumentality of materiality to be re-conceptualized, Hayles (2012) argues for a necessary decoupling of physicality from materiality: the former being an ontologically discrete entity, the latter being an emergent property that comes into existence through an act of engagement or, as she terms it, "attention" which identifies and isolates one or more specific, physical attributes (Hayles, 2012:91). As she notes, "materiality emerges from the dynamic interplay between the richness of a physically robust world and human intelligence as it crafts this physicality to create meaning" (Hayles, 2002:33). The work of Haidy Geismar (2013) on the relationship between materiality and metadata in the world of object management, museum curation, and digital repatriation is apposite here. She argues that the digital should be defined as a form and process rather than a fixed material or medium. The characteristics of digital objects often described as editable, interactive, open, and distributed are, according to Geismar, the result of affective relationships rather than qualities inherent to the digital technologies themselves. Drawing on Horst and Miller's anthropological perspective that "locates the digital *within* the study of social relationships and cultural difference" (Geismar, 2013), she suggests that materiality and sociality are mutually constitutive, being a fluid, interconnected, hybrid landscape of objects and practices. In this view, metadata becomes another word for epistemology; it registers not the specious value-free or neutral description of information, but a socially implicated act of construction that is situated in both time and space. In current debates about distant, machine, or hyper-reading and its relation to traditions of close reading, for instance, literary scholars have recuperated these notions of attention and affect to register the embodied, socially and politically implicated processes of surface or deep reading (Price, 2009; Ramsay, 2011; Nuttall, 2011; Hayles, 2012). Again, responsiveness to the sustained dialectic of materiality underwrites these new directions.

If metadata signals the sociological dimension of digital materiality, then paradata, a term recently coined to describe the automatic and semantic process of capture and documentation of all facets of digital humanities project decision making, exposes its ontological bases and biases, if not metaphysics. Paradata or "processual *scholia*" is a form of intellectual transparency that legitimates "computer-based visualization of cultural heritage … as a valid scholarly method for studying and presenting cultures of the past" (Bentkowska-Kafel *et al*., 2012:245). Like forensic, formal, distributed, and performative materiality, it is recorded in physical traces that reflect, as Willard McCarty points out in relation to computational models, "temporary states in a process of coming to know rather than fixed structures of knowledge" (in Bentkowska-Kafel *et al*., 2012:248). Paradata exposes the nature of what we know but, equally, in conjunction with metadata, can reveal how we know what we know.

Building on Frank Upward's modeling of the records continuum, Australian archives and record-keeping practitioner Sue McKemmish (1996) refers to records and archives as always in "a process of becoming" and claims that they contain both "evidence of me" and "evidence of us," a kind of social contract that changes over time

and space. How do we identify and analyze these relationships between purportedly inanimate and animate objects? One way is through a deep understanding of what, following Gibson (1979), are called "affordances"; that is, a fluid and contingent set of capabilities which define how objects can be used, even as those capabilities differ from user to user and across the spacetime continuum. Affordances are the ways in which nonhuman things or stuff become actors or agents in the construction of knowledge, or what has been termed, in the field of social semiotics, a "dialectical dance" (Sewell, 2005:92). In arguing for a new understanding of the technological shaping of social action rather than an overly simplified and reductive notion of the social shaping of technology, Ian Hutchby (2001) contends that "affordances are not exclusively properties of people or of artifacts – they are constituted in relationships between people and the materiality of the things with which they come in contact … the affordances of an artifact can change across different contexts even though its materiality does not" (Hutchby, in Leonardi, 2010). Perhaps more simply, then, "when those researchers describe digital artifacts as having 'material' properties, aspects, or features, we might safely say that what makes them 'material' is that they provide capabilities that afford or constrain action" (Leonardi, 2010).

The existence of such capabilities or affordances has led to considerable debate about both the materiality and instrumentality of objects, artifacts, and things. Bruno Latour's development of actor–network theory depends on an expansive definition of things to embrace and embody physical objects, animate life-forms, digital objects, concepts, words, bodies of knowledge, and practices as well as a network model of dynamic intersections and translations that register and record the fundamentally "im/mutable mobile" nature of things as actors (Latour, 2005:196). Deleuze and Guattari's (1987) a-linear, non-arboreal concept of rhizomatous networks populated by instantiations of vagabond or nomadic things, constantly mutating and morphing, might model society and culture, but it is also a powerful analogy for objects in a world of digital materiality. The cultural heritage or GLAM sector, composed of galleries, libraries, archives, and museums, deals with objects, whether physical, digitized, or born-digital, all the time. The intellectual frameworks, approaches, and activities of information professionals frequently cross over and, as Kaetrena Davis Kendrick (2013) notes, are surprisingly familiar to digital humanists. Given that many digital humanities projects are located in these public institutions, tracking how the GLAM sector responds to the challenges of digital materiality can offer valuable insights. For example, public outreach has recently taken the form of object biographies that expose the rich, human-inflected stories associated with things through pictorial, textual, and audio narratives. This development offers a contemporary twist on eighteenth-century "it-narratives" with their tales of "babbling banknotes, canting coins, prosing pocket watches and soliloquizing snuffboxes" which gave way in the nineteenth century to fictionalized autobiographies of anthropomorphized talking books traveling, often tragicomically, from one owner and one *mise-en-scène* to the next (Price, 2012:108). In order to animate these objects, Neil MacGregor (2010), director of the British Museum and author of *A History of the World in 100 Objects*, talks about the need for "powerful poetic imagining" resulting in the "necessary poetry of things" (MacGregor, 2010: xv–xvi, xxiii). The lives of everyday objects are coupled with a process of revivification that turns the mundane into the extraordinary.

Museum and data curation specialist Costis Dallas captures the ways in which objects and cultures intersect by using the term "thingformation" to describe "a field of activity-laden, material entanglement" in which digital media are defined "as continuity of thing cultures across digital and physical domains." He suggests that a holistic notion of "thing cultures" might serve as a theoretical foundation for epistemically-adequate digital heritage curation (Dallas, 2011: lecture 4) and proposes a radical rethinking not only of what constitutes the "things" that are the object of curation, but of the very cultures in which they are embedded. For digital objects, these might include "digital infrastructures in cultural heritage – collection management systems, databases, digital collections, research repositories, [and] virtual museums – which unfold material things as loci of culturally situated activity" (Dallas, in Sanderson, 2014). Likewise, Sanderson (2014) is concerned with the performative materiality of heritage objects and the systems which mediate between such objects and the researcher community. She draws attention to the close parallels between Dallas's "thingformation" and Upward's' "continuum theory" and argues that the development of knowledge-enabling systems across the GLAM sector would be better served by theory and practice that recognizes the inherently complex nature of objects.

Such a sociological perspective on the interpenetration of things and cultures is shared by philosopher Jane Bennett (2010), who discusses what she terms "thing-power" in the context of vibrant matter and the political ecology of things. Marshaling figures as diverse as Lucretius, Spinoza, Darwin, and Latour, she argues for a vital materialism that works against the grain of anthropocentrism and historical materialism. She contends that "we need to cultivate a bit of anthropomorphism – the idea that human agency has some echoes in nonhuman nature – to counter the narcissism of humans in charge of the world" (Bennett, 2010:xvi). However, like many scholars faced with essentializing materiality, she acknowledges the challenges of trying to describe the self-sufficiency of the object–subject/human–nonhuman relationship. It might very well be, then, that in place of virtuality, magic has become the new space for imagining the digital. Literary scholar Steven Connor's *Paraphernalia*: *The Curious Lives of Magical Things* (2013) places "enchantment" at the forefront of material culture. Evoking the specific experience rather than the generic type, Connor offers a forensic analysis of personal, material engagements with the once-new: things that impart what he calls "the shock of the newly old." As he remarks:

> such things inhabit space, but are a kind of temporizing with it, a refracting of the white noon of the now into a chronic rainbow of times, with their twilight tints and hues. Such things hum with hint and import because they are there without being fully present; to hand, but not exactly *here-and-now*. (Connor, 2013:8)

From flickering screens to human-techno hybrids, digital materiality is central to the concepts, methods, and practices in and of the digital humanities. Using a toolkit that ranges from the forensic and formal, to distributed and performative materiality, we can reflect on the emergent, yet always historically situated, properties of the here and now. In his short essay "Excavation and memory," Walter Benjamin (1932/2005) posits that it is not the object itself or the inventory of the archaeologist's findings that is important, but rather, the act of marking the precise location where it is found

(Benjamin, 2005:576). In recording such acts of engagement and enchantment, digital humanists inhabit a world of reflective practice shared by media archaeography, and at the heart of which reside key questions about digital materiality. If Jonathan Franzen's *Freedom* (2010) exists as a wireless Kindle download, a torrent-released pirate, a corrupt UK recall, 45 Amazon formats and editions, and a multiverse of social-media engagements generated by Franzen's fan-atics, the history of this work is already complex: even more so if the author's creative process resides in an outmoded Dell machine with its digital palimpsests that may or may not be collected as part of his literary archive (Kirschenbaum and Werner, 2014:423–5). As Ian Hutchby (2001) proposes, "rather than restricting the analytic gaze to the construction of accounts and representations or the technology, we need to pay more attention to the material substratum which underpins the very possibility of different courses of action in relation to an artifact; and which frames the practices through which technologies come to be involved in the weave of ordinary conduct" (Hutchby, 2001:450).

References and Further Reading

Benjamin, W. 2005. *Selected Writings, Vol. 2, part 2 (1931–1934), "Ibizan Sequence" 1932*, ed. M.P. Bullock, M.W. Jennings, H. Eiland, and G. Smith. Cambridge, MA: Belknap Press, 576.

Bennett, J. 2010. Thing-power. In *Political Matter: Technoscience, Semocracy, and Public Life*, ed. S. Whatmore and B. Braun. Minneapolis: University of Minnesota Press.

Bentkowska-Kafel, A., Denard, H., and Baker, D., eds. 2012. *Paradata and Transparency in Virtual Heritage*. Farnham: Ashgate.

Berry, D. 2012. Introduction: understanding digital humanities. In *Understanding Digital Humanities*, ed. D. Berry. London: Palgrave Macmillan, 1–20.

Chandler, J., Davidson, A.I., and Johns, A. 2004. Arts of transmission: an introduction. *Critical Inquiry* 31 (1), 1–6.

Chartier, R., and Cavallo, G. 1999. Introduction. In *A History of Reading in the West*. Amherst: University of Massachusetts Press.

Connor, S. 2013. *Paraphernalia: The Curious Lives of Magical Things*. London: Profile Books.

Dallas, C. 2011. Thingformation: informing thing cultures, curating digital heritage, Lecture series 22 March – 5 April 2011. Digital Curation Institute, Faculty of Information, University of Toronto. http://entopia.org/costisdallas/2011/04/05/spring-lecture-series-at-the-digital-curation-institute-university-of-toronto (accessed January 15, 2014).

Deleuze, G., and Guattari, F. 1987. *A Thousand Plateaus: Capitalism and Schizophrenia*. Trans. Brian Massumi. Minneapolis: University of Minnesota Press.

Drucker, J. 1994. *The Visible Word: Experimental Typography and Modern Art,* 1909–1923. Chicago: University of Chicago Press.

Drucker, J. 2003. The virtual codex from page space to e-space. http://www.philobiblon.com/drucker (accessed January 15, 2014).

Drucker, J. 2013. Performative materiality and theoretical approaches to interface. *DHQ: Digital Humanities Quarterly* 7 (1). http://digitalhumanities.org:8080/dhq/vol/7/1/000143/000143.html (accessed January 15, 2014).

Eggert, P. 2005. Text-encoding, theories of the text, and the "work-site". *Literary and Linguistic Computing* 20 (4), 425–35.

Erickson, P. 2003. Help or hindrance? The history of the book and electronic media. In *Rethinking Media Change: The Aesthetics of Transition*, ed. D. Thorburn and H. Jenkins. Cambridge, MA: MIT Press, 95–116.

Ernst, W. 2011. Media archaeography: method and machine versus history and narrative of media. In *Media Archaeology. Approaches, Applications, and Implications*, ed. E. Huhtamo and J. Parikka. Berkeley: University of California Press, 239–55.

Galey, A. 2012. "The enkindling reciter": e-books in the bibliographic imagination. *Book History* 15, 210–47.

Geismar, H. 2013. Defining the digital: a comment. *Museum Anthropology Review* 7 (1–2), 254–63. http://scholarworks.iu.edu/journals/index.php/mar (accessed January 15, 2014).

Gibson, J.J. 1979. *The Ecological Approach to Visual Perception*. London: Houghton Mifflin.

Gitelman, L. 2006. *Always Already New. Media, History, and the Data of Culture*. Cambridge, MA: MIT Press.

Hand, M. 2008. *Making Digital Cultures: Access, Interactivity, and Authenticity*. Aldershot: Ashgate.

Hayles, N.K. 2002. *Writing Machines*. Cambridge, MA: MIT Press.

Hayles, N.K. 2012. *How We Think: Digital Media and Contemporary Technogenisis*. Chicago: The University of Chicago Press.

Hindmarsh, J., Heath, C., and Fraser, M. 2006 (Im) materiality, virtual reality and interaction: grounding the "virtual" in studies of technology in action. *The Sociological Review*, 54 (4), 795–817.

Hutchby, I. 2001. Technologies, texts and affordances. *Sociology* 35 (2), 441–56.

Kendrick, K.D. 2013. Keeping the "L" in digital: applying LIS core competencies to digital humanities work. *Journal of Creative Library Practice*. http://creativelibrarypractice.org/2013/09/06/keeping-the-l-in-digital-applying-lis-core-competencies-to-digital-humanities-work (accessed January 15, 2014).

Kirschenbaum, M.G. 2008. *Mechanisms: New Media and the Forensic Imagination*. Cambridge, MA: MIT Press.

Kirschenbaum, M.G., and Werner, S. 2014. Digital scholarship and digital studies: the state of the discipline. *Book History* 17, 406–58.

Latour, B. 2005. *Reassembling the Social: An Introduction to Actor–Network Theory*. Oxford: Oxford University Press.

Lavagnino, J., McCarty, W., and Schreibman, S. 2007. Digital representation and the Hyper Real. http://www.digitalhumanities.org/dh2007/abstracts/xhtml.xq?id=219 (accessed January 15, 2014).

Leonardi, P.M. 2010. Digital materiality? How artefacts without matter, matter. *First Monday* 15, 6–7. http://www.uic.edu/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/3036/2567 (accessed January 15, 2014).

Liu, A. 2004. Transcendental data: toward a cultural history and aesthetics of the new encoded discourse. *Critical Inquiry* 31 (1), 49–84.

MacGregor, N. 2010. *A History of the World in 100 Objects*. New York: Viking. http://www.britishmuseum.org/explore/a_history_of_the_world.aspx (accessed January 15, 2014).

Manoff, M. 2006. The materiality of digital collections: theoretical and historical perspectives. *portal: Libraries and the Academy* 6 (3), 311–25.

McGann, J. 1991. The socialization of texts. In *The Textual Condition*. Princeton, NJ: Princeton University Press, 69–83.

McGann, J. 2001. Visible and invisible books in *n*-dimensional space. In *Radiant Textuality: Literature after the World Wide Web*. London: Palgrave Macmillan, 167–91.

McKemmish, S. 1996. Evidence of me. *Archives and Manuscripts* 24 (1), 28–45. http://www.infotech.monash.edu.au/research/groups/rcrg/publications/recordscontinuum-smckp1.html (accessed January 15, 2014).

McKenzie, D.F. 1999. *Bibliography and the Sociology of Texts.* The Panizzi Lectures (1986). Cambridge: Cambridge University Press.

McKenzie, D.F. 2002. "What's past is prologue": the Bibliographical Society and the history of the book. In *Making Meaning: "Printers of the Mind" and Other Essays*, ed. P.D. McDonald and M.F. Suarez. Amherst: University of Massachusetts Press, 259–75.

Nuttall, S. 2011. The way we read now. http://slipnet.co.za/view/blog/sarah-nuttall/the-way-we-read-now/ (accessed January 15, 2014).

Orlikowski, W. 2006. Material knowing: the scaffolding of human knowledgeability. *European Journal of Information Systems*, 15 (5), 460–6.

Parikka, J. 2012a. New materialism as media theory. medianatures and dirty matter. *Communication and Critical/Cultural Studies* 9 (1), 95–100.

Parikka, J. 2012b. *What is Media Archaeology?* Cambridge: Polity Press.

Price, L. 2009. From the history of a book to a "history of the book". *Representations* 108, 120–38.

Price, L. 2012. *How to Do Things with Books in Victorian Britain*. Princeton and Oxford: Princeton University Press.

Ramsay, S. 2011. *Reading Machines: Toward an Algorithmic Criticism*. Urbana: University of Illinois Press.

Sanderson, K. 2014. Digital materiality, heritage objects, the emergence of evidence, and the design of knowledge enabling systems. PhD thesis, Victoria University of Wellington.

Sewell, W.H.J. 2005. The concept(s) of culture. In *Practicing History: New Directions in Historical Writing after the Linguistic Turn*, ed. G.M. Spiegel. New York: Routledge, 76–95.

Siemens, R., Elkink, M., McColl, A., *et al*. 2010. Underpinnings of the social edition. In *Online Humanities Scholarship: The Shape of Things to Come*, ed. J. McGann. http://cnx.org/content/m34335/1.2 (accessed January 15, 2014).