Thinking as Handwork: Critical Making with Humanistic Concerns

Gabby Resch, Dan Southwick, Isaac Record, and Matt Ratto

Thinking Is Handwork[1]

Late one night, in the spring of 2015, two members of our group found themselves hunched over a lab bench strewn with skeins of wire insulation and plastic shavings, brainstorming over a seemingly unsophisticated, but remarkably complex, challenge: how does one go about making a semi-hollow piece of plastic *feel like* a hand-worn chunk of solid ivory? We experimented with a number of shop-room hacks, from buffing the object's striated surface with a mixture of animal fat and carnauba wax until it had the 'worn' texture and look we expected a piece of aged ivory would have, to drilling a hole in its base and filling it with fine sand in an attempt to simulate how an ivory object of similar size might weigh on one's hand. This exercise was part of an experiment in creating 3D-printed replicas of ivory busts from a collection at the Art Gallery of Ontario. The busts they reproduce are themselves replicas, originally produced on a Victorian-era pantograph machine (which can be thought of as a nineteenth-century precursor to modern CNC and 3D-printing technology) invented by Benjamin Cheverton, a notable artist, craftsperson, and engineer, for the Great Exhibition of 1851. Each of these replicas would have been painstakingly copied mechanically from much larger marble busts, many hand-carved by Sir Francis Chantrey, the leading portrait sculptor during Regency-era Britain.

Even if, in a Benjaminian sense, works of art have *always been reproducible*, a number of provocations were stirred up by this reproduction work that critical digital humanists might attend to. We might consider how the overwhelmingly upper class, male social network that inspired Chantrey (and, consequently, Cheverton) does not attract significant attention in an art museum filled with works of similar inspiration. Or we could interrogate the vectors along which the Victorian ivory trade, a key facet of British imperialism, produced a medium that continues to haunt museums. With a primary motivation to weigh various techniques that might make our object feel more or less 'real,' we had to sift through and across a mangle of practice (Pickering) that requires drawing on a diverse array of digital pre-production techniques, leveraging our own tacit knowledge of a chain of processes--both material and digital--that constitute 3D printing as

a distinct medium, and performing an ongoing negotiation of critical issues that deal with curatorial and institutional authority, authenticity, and the relationship between the materiality of museum artifacts and their increasingly digital-material surrogates. These concerns undergird our ongoing experiments in replication.

In this chapter, we describe some ways of thinking productively about materiality by illustrating how our material interventions have troubled theoretical work (and vice versa). We elaborate on what we recognize as opportunities for digital humanists as well as science and technology studies (STS) scholars who are involved (or implicated) in an ongoing discussion about the use of methods of inquiry inspired by critical making (Ratto), especially in work that engages with cultural institutions like galleries, libraries, archives, and museums. We describe recent experiences our lab--which is composed of members with diverse scholarly backgrounds extending from philosophy of science to Chinese history and technical backgrounds ranging from electrical engineering to systems administration--has had building and deploying objects and experiences, most of which use 3D printing as a medium, in a handful of world-class museums. These projects cut across humanities and STS themes, and generally necessitate interdisciplinary tactics. Taken together, they broaden an ecology of iterative software and hardware work, interaction techniques, and scholarly practices that we regularly invoke, adapt, and re-imagine. A host of fundamental issues inform this work, including how scientific and cultural knowledge are regularly co-produced in cultural institutions; how infrastructures that cross disciplinary boundaries can share objects, methods, and features along digital and material axes; and how new technologies that afford greater interaction across material and digital spaces propose to change the ways cultural institutions engage their publics. These issues remain open and messy, but we hope our examples will contribute to a necessary dialogue that many of us are already embedded in.

[INSERT FIGURE 16.1 (figure16_1Resch1.jpg) NEAR HERE]

Atoms, Bits, Media, Matter

There is a seductive trap that scholars fall into when we articulate our work as residing somewhere along a material-digital continuum, or using approaches and techniques that blur

material and digital distinctions. Troubling the dichotomy between material and digital comes naturally in the academy, where we can ruminate endlessly about whether inscribed bits on a hard drive are continuous or discrete, or whether digitality is implemented over a continuous analog substrate (Smith). A significant proportion of our lab's research considers the materiality of digital infrastructures, and we generally operate from a position that many digital humanists likely agree with: that the digital is always material. Computation can be thought of as "fundamentally a modeling activity" where a correspondence between domains that are generally treated distinctly (e.g. digital and material) must be established (Isbell et al., 198). But computation is a phenomenon where real-world effects aren't just mirrored in digital space… they are entangled with digital representations. 3D modeling, as a computational activity that is generally guided by the logic of a correspondence theory of representation - the "closer it is to the real thing, the better" (Lynch, 217)[2] – is a site where this entanglement is especially pronounced.

These are productive and enriching dialogues for scholars, but our attempts to unsettle the marked distinction between digital and material culture meet resistance from cultural heritage professionals who have to reconcile this distinction in their work--especially those who consider "the digital" necessary but threatening at the same time. Digital culture can challenge their institutional mandates (e.g., "Why should the public go to a museum when they can see the same content on an iPad at home?" is a familiar refrain, however short-sighted it might be). Rather than thinking of material and digital as distinct entities that meet and occasionally blur into each other, that overlap, or are possibly even implemented atop one another, we frequently encounter them in our work as entangled phenomena, situated in a gradient along which agential possibilities are distributed among human and non-human entities and cut by a wide and ever-changing array of social, technical, and institutional concerns (Barad). Compounding this digital-material entanglement, we have also come to think of 3D reproduction as a unique medium that actively figures and influences the processes in which digital objects are re-shaped into analog/material ones.

These factors influence the way our group does critical making, especially in humanistic contexts. We engage, often unequally, with ideas from STS, critical theory, digital humanities, design, feminist technoscience, human-computer interaction (HCI), maker cultures, and a number of cognate disciplines and movements. As the projects we describe (hopefully) indicate,

critical making invokes a methodological position that encourages reflexive interrogation of the politics of sociotechnical objects and systems, as well as the politics of institutions we engage with (and deeply care about)--particularly as they are forced to navigate a rupture in how the public perceives their relevance at a time of increasing austerity. In the sense that we draw selectively upon specific theoretical methods, requiring hands-on engagement as an additional resource, theory both guides, and emerges from, critical making projects our lab undertakes.

This does not have to be "digital" making, though, or even participatory making (as exemplified by the "maker" movement), but it should attempt to reconcile a schism that exists between those who purportedly create digital (and digital-derived) content in institutional contexts and those purportedly tasked with representing and interpreting it (as if they are always discrete groups). For us, 'doing theory' with critical making[3] entails moving beyond shallow critical reflection, or mere acknowledgment of the relational ontologies brought to bear on the institutional contexts our work intersects with. But theory cannot be taken for granted. Many reports seem to give passing reference to theoretical perspectives, rather than demonstrating deep engagement with them. This is especially problematic in projects that illuminate unequal power distributions and then purport to somehow grant greater agential capacity to actors who would previously have been rendered invisible, mute, or obsolete (as if agency is something we, as makers or scholars, can grant[4]). The projects we engage with use theoretical concepts in occasionally utilitarian, but generally non-deterministic, ways to think through the agential possibilities, temporal conditions, and materiality of institutions.

While we do not intend for our critical making work to be grounded in instrumental logic, there is a constant negotiation between instrumental and aesthetic concerns when we do this work with cultural institutions. Considerations including how we can *use* 3D printing to make museum objects 'more interactive' abound. Traditional value propositions and epistemic commitments we might encounter in scientific and artistic communities--utility and empirical rigidity, on the one hand; expression and empirical flexibility, on the other--are troubled by considerations toward assessment. We are also not strictly beholden to questions of aesthetics, the pragmatics of institutional relationship development, or even rigid arguments about the relative value of processual acts versus evocative objects (although we likely lean toward the former). Among the most interesting discoveries we have encountered in our engagements with

cultural institutions is a heightened sensitivity to how preparation of an object for display can be a more important locus of epistemic activity than the exhibited object itself.

We are not going to pretend to have a definition of DH that works for everyone, or even to be as intimately familiar with DH concerns as many of the readers of this book might be. If we understand critical computational inquiry in the humanities as both the interrogation of digital tools used by humanities scholars and the use of digital tools to interrogate theoretical claims about how the reproduction of culture occurs, then we might assume that creating and understanding digital archives of cultural 'data' should be a core concern of the H/DH archipelago (given that some of the most mature and robust computational tools reside in this space). What are the intersections of "humanistic concerns and digital capabilities" (Drucker, *SpecLab,* 64) at which a critical making approach might present valuable insight? Should there be an agreed-upon description of "humanistic concerns" that we can take as a starting point? What might some "acceptable" maker activities for humanities scholars be if such activities use immature technologies that have not received official institutional sanction? Is humanities scholarship better served by taking *the act of* prototyping as a form of pedagogy, or by insisting on the release of full-fledged investigative tools into the wild, where so many of them meet a lonely death? We have not generally had to reconcile our work with claims that tools, if they are to be taken as theories, should be accessible, transparent, and available to peer review, although we tend to agree with such claims (Ramsay and Rockwell). For the most part, we are sensitive to a critique that using computers to manipulate or interpret humanities data does not always constitute theorizing.

With these points in mind, we would like to propose that 3D rematerialization (which expands from 3D printing's additive qualities to include the subtractive qualities of CNC routing or laser cutting) is a kind of visualization technique appropriate for certain humanities concerns. We have undertaken a handful of recent projects guided by this consideration. One involved a collaboration between members of our lab and an international team of researchers and artists at the Art Gallery of Burlington in which we captured embodied gestural data performed during craft practice, and artistically reproduced the data as physical 3D-printed instantiations. Another involved members of our lab collaborating with the Royal Ontario Museum to produce 3D printed tactile representations of 2D digital images that have been included in an annual photography exhibit and are now in the museum's teaching collection. This project, which began

by algorithmically displacing and manipulating colour values in digital images, but ultimately required a significant amount of hand "sculpting" that crossed the material-digital gap, introduced a new mode of sensory engagement for non-sighted (as well as sighted) visitors to the museum. Despite the success of these collaborations, we are not particularly "eager to suspend critical judgment in a rush to visualization" (Drucker, "Humanities Approaches to Graphical Display," 1), likely because prototypes and half-finished iterations generally satisfy the requirements of our work. Beyond the issues listed earlier, there are a host of possibilities, affordances, and opportunities inherent in 3D work that require greater attention. These include how 3D-driven investigations inform the recent dialogue around "making" in humanities scholarship; what 3D-based curricula for museum and DH professionals that extends across a full chain of activities--from capture (digitization) to cleanup and design (digital artisanship) to printing (rematerialization) to finishing (material artisanship)--might look like; and how the public should be engaged in participatory and collaborative 3D making experiences that promote sustained engagement with cultural heritage.

The 3D Museum Medium

The fact that many museums are already well-versed in 3D scanning and printing technology (for conservation purposes, at least), and that there is a shallow enough argument that museums are *already* 3D in the first place, should temper the hype about 3D printing as an "ideal" technology for museum-based humanistic inquiry. But there is an interesting--albeit troubling--trend under way in which 3D printing is being positioned as a technology that museums might (and, in some cases, should) embrace to develop new modes of interaction between humans and artifacts (Sportun). While 3D printing has inhabited a role as one of the pre-eminent maker technologies, its integration in cultural space necessitates a host of critical considerations. These include questions about the materiality of the medium (e.g., what happens to all this plastic ephemera, particularly when printing happens on-site, as it off-gases or disperses in the presence of priceless artifacts?), the expertise of operators (e.g., is it a black box-able technology, as numerous manufacturers hope, or does it require the kind of tacit knowledge, experience, and care that comes from opening up its hardware?), and who it ultimately serves (e.g., are museums being herded by STEM-funding agencies into initiatives that promote training members of the

public to meet the world's crises, and, if so, who in the museum benefits from these neoliberal narratives?). While there is a growing body of creative and playful examples of museum-based 3D, we can offer scant evidence of the medium's use in critical provocations that challenge the institution itself.

There is an ongoing paradigm shift in how the museum world and some members of the public regard museums (Anderson)--from collections-centered, traditional institutions to visitor-centered, reimagined public institutions. The two do not necessarily have to be mutually exclusive, and some recent evidence suggests that museums might cautiously warm to participatory culture without disregarding their past mandates (Söderqvist). This is a contested idea, and there is also evidence of backlash toward the participatory museum. Concomitant with the paradigm shift Gail Anderson describes, challenges to curatorial/institutional authority, a troubling of the power of objects to tell stories, and an animated debate over what constitutes an exhibit are also under way. As critical STS scholars with humanistic leanings, we are naturally drawn to projects that illuminate the politics of institutional authority. So how do we reconcile the critical work we do with the politics of the institutions we work with? Consider the following example.

In 2013, members of our group collaborated with a team of partners to create and implement a 3D design and printing experience at the Royal Ontario Museum. Visitors to the museum were invited to use iPads to create unique pieces of an imaginary Mesopotamian city that were 3D-printed *in situ* and installed in a dynamic, collective, participatory exhibit. Throughout the exhibit's run, which was staged on Friday nights as part of a public engagement that turns the museum into a kind of nightclub for thousands of (mostly young) adults, a number of unanticipated situations emerged. A significant number of participants experimented with deliberately anachronistic designs, many resembling modern skyscrapers. Others collapsed columns into ziggurats or turned temples upside-down. One visitor referred to a sleek, modernist obelisk they created as a "Mesopotamian Freedom Tower." This particular example would probably horrify curators or museum interpreters, who are not only accountable to visitor experiences, but also responsible for representations of history and culture. We, however, were presented with an opportunity to think critically about how museums use new technologies to structure temporality and present authoritative institutional narratives, and, furthermore, to

consider whether these narratives are commensurable with claims that technologies like 3D printing afford the ability to re-create, or even reimagine, the past.

In another example, described in the opening paragraph of this chapter, we prepared touchable models for an exhibit at the Art Gallery of Ontario (AGO). This exhibit, which highlights busts of notable figures like James Watt (who was a contemporary of Cheverton, the pantograph's inventor), might initially be read through a kind of *Leviathan and the Air-Pump* network analysis, where critical scholars might look for evidence of epistemic cultures in the material record of the collection. There is also interesting historiographical work that intersects with critiques of contemporary curatorial regimes. What and whose histories are collected and represented in such a collection, and how are they troubled when the mode of interaction the public uses to engage with the collection is reimagined? The experience of preparing pieces for an exhibit that speaks to historical power dynamics and modes of production, as well as contemporary meta questions about the role of technology in museum interaction, was illuminating for us. It informed ongoing theoretical discussions members of our lab have had about the history of ocularcentric interaction and the politics of touch in memory institutions. Additionally, it forced us, as STS scholars with critical humanistic tendencies, to reflexively look inward, at our own practices, relationships, and epistemic commitments. In addition to its use in participatory culture experiments, 3D printing is increasingly proposed as a technology that affords new modes of interaction for inclusivity or accessibility purposes. In the exhibit, the presence of a screen looping a video of our 3D making process, positioned adjacent to a touchable bust, performs a mediating role that calls attention to the museum's willingness to use new technologies to both become more accessible and be perceived as relevant. A similar video was displayed alongside the previously mentioned tactile models we prepared for the ROM. Museums are beginning to play up this aspect of 3D printing in their marketing, suggesting that 3D printing technology somehow connects them with the past and the future at the same time, while extending their collections to a wider audience. These uncomplicated narratives can seem scripted by the manufacturers of maker technologies, and we are not entirely comfortable being associated with them.

Returning to the problem of conceptualizing a material-digital entanglement that must be attentive to institutional politics, we recognize a growing tendency toward characterizing 3D-printed objects as composed of digital instructions implemented in a material substrate. This

tendency overlooks, and often erases, the considerable amount of handwork that goes into the digital composition and preparation of printed artifacts. Such handwork includes the embodied act of capturing an object and digitizing it; the somewhat skeuomorphic enactment of a digital drafting station that requires a pressure-sensitive stylus and tablet to digitally sculpt and prepare scanned data; and post-processing work that entails cleaning up random bits of digital noise that get materialized (something the AGO also highlighted in the accompanying video, as their videographer focused on images of one of our hands trimming residual bits of plastic). But this is not just handwork. It requires a more sophisticated temporal understanding of what it means to do material work. The *matter* of 3D printing resists stability--it desires to disperse, settle, and blend, generating latent chemical effects that humans must be wary of, particularly conservationists who have to weigh how 3D printed objects might off-gas, or how the process, if done *in situ*, might emit ultrafine particles into the serene container of museum space.[5] It is not enough for us to offer assurances that the wild west of 3D printing is supported by a few decades of anecdotal evidence claiming our conventional practices are nothing to be concerned about. We must account for why this would be an institutional issue in the first place.

Making Things Matter Together

As a point of departure, we take Alan Liu's suggestion that DH can learn from how STS approaches culture, technology, and society. Liu proposes that engaging with STS "would help the digital humanities develop an understanding of instrumentalism--including that of its own methods--as a culture embedded in wider culture" (502). Further, we argue that critical making with humanistic concerns could serve as a bulwark against a tendency by scholars, humanists among them, to replace technological determinism with social determinism (Latour, 84). Liu writes, "Only by creating a methodological infrastructure in which culturally aware technology complements technologically aware cultural criticism can the digital humanities more effectively serve humanists by augmenting their ability to engage today's global-scale cultural issues" (502). There is work that DH and STS can do together that might enable us to productively intervene in society. We could devise joint tactics to face the "problem" of digitization. We could expose flawed, deterministic tendencies that pervade our disciplines. We could highlight the troubling

conflation of digital literacy with critical sociotechnical and information literacy, when these mean quite different things but are often used interchangeably.

There is undoubtedly a plethora of worthwhile critical scholarship falling under the aegis of digital humanities, STS, and even HCI that uses "making" as a productive and reflexive process. Together, we might extend the reflexive modes of engagement that are boundary-agnostic. Surely, some of the "little hacks" we deploy in STS-grounded work can be ported to humanistic contexts. A far more interdisciplinary framing than DH-meets-STS is required, however, if we are going to construct the methodological apparatus that Liu calls for. (This includes recognition of projects in adjacent fields like HCI that have pursued similar goals.)[6] For our lab, this means drawing from contemporary museology, interaction design, media theory, and STS's increasingly distant parent, philosophy of science (which hovers in the background, as Willard McCarty has noted (McCarty, 17)).

Following Barad, we recognize an "entanglement of matter and meaning" that calls into question erroneous dichotomies which place nature apart from culture and separate matters of fact from matters of concern (Latour) and matters of care (de la Bellacasa).[7] This is especially important if matters of fact--nature, raw data, positivist empirical study, and scientific realism--can no longer be recognized as solely within the domain of natural sciences, and matters of concern--culture, social constructivism, values—have moved beyond the humanities and social sciences. Like Barad, we seek to recognize the ways that science and humanities are already entangled, and to trace diffraction patterns that record the history of interaction, interference, reinforcement, and difference between them. This requires taking into account how each "culture" recognizes another significant entanglement--between *matter* and *relevance*. Do the concerns that matter to us, as humanists and humanities allies, conflict with agendas that define how our work is deemed relevant? We must ask who we want to be accountable to, as well as how the epistemic products of our work produce a kind of relevance that can be tough to measure. In the interest of staging a "productive intervention in society," we must also ask: what is the kind of advocacy work that we want to do? Maybe we need to develop pervasive technologies and experiences that, as Liu suggests, "fundamentally reimagine humanities advocacy" (497) and enhance the ability of humanistic scholarship to both communicate and resonate with the general public. In that case, sites such as museums, where the public effectively meets the humanities face-to-face, would be ideally productive sites of intervention.

We must also unbox the epistemic objects (Cetina) that humanistic and STS-informed making might share, or the boundary objects (Star and Griesemer) that might enable translation across epistemic disjunctures. Critical making, as we propose it, is more a mode of critically reflexive (even transformative) inquiry than a record of scholarly activity. While knowledge production might be a core concern of both STS and humanities, our work is not directly concerned with tracing scholarly knowledge production. Writing object biographies of digital making experiences may be a "way of knowing," and situating researchers in these unwieldy biographies may be a political act (Morgan), but we also need to look for theories in prototypes and, following Galey and Ruecker, recognize that our projects may end up being interpreted as rhetorical devices to "be used in persuasive performances" (Ramsay and Rockwell, 78). Without opening up the extensive debate about distant reading, critical making enables a close reading of objects that are never fixed. Direct material engagement is a "condition for knowing," and this is not "knowing from a distance" (Dolphijn and van der Tuin, 52). We might see it somewhat adjacent to what Gabriel Bodard espoused when he recently tweeted[8] that, while DH often focuses on distant reading, he advocates "detailed modelling, 'zooming in' not out" (n. pag.). Critical making offers a form of distant reading and close reading at the same time, attending closely to institutional artifacts as well as the networks upon which they travel--without privileging one over the other. It provokes a thoughtful examination of the murky suspension in which bits of material and digital worlds collide. Moreover, it encourages an examination of the different value propositions associated with reflexive material and semiotic engagement. The projects we have highlighted force us to revisit many of the Benjaminian notions we might entertain about digital reproduction and simulation, while also offering new insights into concerns that should be of interest to humanities scholars, such as the increasing algorithmic nature of lexico-discursive work in DH. Is the handwork of 3D always an alternative to the "algorithmic" when much of it is done procedurally through computer-aided design?

If STS and humanities scholars are going to successfully collaborate using modes of engagement similar to the ones we have described, then we must first examine our own goals. Are we looking to address critical questions or to demonstrate them? Are we illustrating how things come to matter, or are we exploring how they come to matter through process? Understanding a critical issue does not automatically count as an intervention, just as a critical intervention does not automatically ensure understanding. We hope that, by mandating direct

material engagement as a condition for knowing, a critical making approach to humanistic concerns can do away with some of these unnecessary conflations. Projects such as the ones we have described offer new avenues into the politics of representation, exhibition, memory, and institutional knowledge. At the same time, they serve as platforms for critically interrogating the sociotechnical systems that are increasingly foisted on institutions struggling to demonstrate their relevance.

We need to be mindful of the multiple meanings of *audience* in these endeavours, though. If the benefits to be derived are often for the makers and, potentially, their scholarly audience, then does critical making count as scholarship, pedagogy, advocacy, or all of the above? It is often hard to tell. What we can be sure of, however, is that this is a perfect moment to find oneself hunched over a messy lab bench at two in the morning, mesmerized by the cacophony of a room full of Cartesian robots dancing back and forth, and trying to meet some institution's deadline while pondering the entanglements of meaning and matter, subject and object, material and digital, and--of course--handwork and headwork.

Bibliography

Anderson, Gail, ed. *Reinventing the Museum: Historical and Contemporary Perspectives on the Paradigm Shift.* Lanham, Md.: Rowman Altamira, 2004.

Barad, Karen. "Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter." *Signs* 28, no. 3 (2003): 801–31.

Bennett, Jane. *Vibrant Matter: A Political Ecology of Things*. Durham, N. Car.: Duke University Press, 2009.

Cetina, Karin Knorr. "Objectual Practice." In *Knowledge as Social Order: Rethinking the Sociology of Barry Barnes,* ed. Massimo Mazzotti, 83–97. Farnham, U. K.: Ashgate Publishing, 2008.

de la Bellacasa, Maria Puig. "Matters of Care in Technoscience: Assembling Neglected Things." *Social Studies of Science* 41, no. 1 (2011): 85–106.

Dolphijn, Rick, and Iris van der Tuin. "'Matter Feels, Converses, Suffers, Desires, Yearns and Remembers': An Interview with Karen Barad." In *New Materialism: Interviews and*

Cartographies, ed. Rick Dolphijn and Iris van der Tuin, 48–70. Open Humanities Press, 2012.

Drucker, Johanna. ""Eye-Mind-Design-Production: An Interview with Johanna Drucker." *MATLIT* 1, no. 1 (2013): 169–177.

———. "Humanities Approaches to Graphical Display." *Digital Humanities Quarterly* 5, no. 1 (2011): 1–21.

———. *SpecLab: Digital aesthetics and projects in speculative computing.* Chicago, Ill.: University of Chicago Press, 2009.

Galey, Alan, and Stan Ruecker. "How a Prototype Argues." *Literary and Linguistic Computing* 25, no. 4 (2010): 405–24.

Isbell, Charles L., Lynn Andrea Stein, Robb Cutler, Jeffrey Forbes, Linda Fraser, John Impagliazzo, Viera Proulx, Steve Russ, Richard Thomas, and Yan Xu. "(Re) defining computing curricula by (re) defining computing." *ACM SIGCSE Bulletin* 41, no. 4 (2010): 195–207.

Liu, Alan. "Where Is Cultural Criticism in the Digital Humanities?" In *Debates in the Digital Humanities*, ed. Matthew Gold, 490-509. Minneapolis, Minn.: University of Minneapolis Press, 2012.

Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network-Theory (Clarendon Lectures in Management Studies)*. Oxford, U. K.: Oxford University Press, 2005.

Lynch, Michael. "Science in the Age of Mechanical Reproduction: Moral and Epistemic Relations Between Diagrams and Photographs." *Biology and Philosophy* 6, no. 2 (1991): 205–26.

McCarty, Willard. *Humanities Computing*. London, U. K.: Palgrave Macmillan, 2005.

Morgan, Colleen Leah. "Emancipatory Digital Archaeology." PhD dissertation, University of California, 2012.

Pickering, Andrew. "The Mangle of Practice: Agency and Emergence in the Sociology of Science." *American Journal of Sociology* 99, no. 3 (1993): 559–89.

Ramsay, Stephen, and Geoffrey Rockwell. "Developing Things: Notes toward an Epistemology of Building in the Digital Humanities." In *Debates in the Digital Humanities,* ed. Matthew Gold, 75–84. Minneapolis, Minn.: University of Minnesota Press, 2012.

Ratto, Matt. "Critical Making: Conceptual and Material Studies in Technology and Social Life." *The Information Society* 27, no. 4 (2011): 252–60.

Sengers, Phoebe, Joseph Kaye, Kirsten Boehner, Jeremiah Fairbank, Geri Gay, Yevgeniy Medynskiy, and Susan Wyche. "Culturally Eembedded Ccomputing." *Pervasive Computing*, IEEE 3, no. 1 (2004): 14–21.

Simon, Jules. *Art and Responsibility: A Phenomenology of the Diverging Paths of Rosenzweig and Heidegger*. London, U. K.: Bloomsbury Publishing, 2011.

Smith, Brian Cantwell. "The Devil in the Digital Details: Digital Abstraction and Concrete Reality." Unpublished draft, last modified 2003.

Söderqvist, Thomas. "The participatory museum and distributed curatorial expertise." *NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin* 18, no. 1 (2010): 69–78.

Star, Susan Leigh, and James R. Griesemer. "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39." *Social Studies of Science* 19, no. 3 (1989): 387–420.

Sportun, Samantha. "The Future Landscape of 3D in Museums." In *The Multisensory Museum: Cross-Disciplinary Perspectives on Touch, Sound, Smell, Memory, and Space,* ed. Nina Levent and Alvaro Pascual-Leone 331–341. Rowman and Littlefield, 2014.

---

[1] This heading and the title of this chapter are inspired by two things: a passage on the "thingly character" inherent in Heidegger's assertion that "denken ist/als handwerk" (Simon, 188–89); and a recent Instagram post by Natalie Jeremijenko: https://instagram.com/p/4xDWUcTG7h.

[2] And, if so, how do we reconcile it with Johanna Drucker's assertion that "rendering observation (the act of creating a statistical, empirical, or subjective account or image) as if it were the same as the phenomena observed collapses the critical distance between the phenomenal world and its interpretation, undoing the basis of interpretation on which humanistic knowledge production is based. We know this. But we seem ready and eager to suspend critical judgment in a rush to visualization?" (Drucker, "Humanities Approaches to Graphical Display," 1).

[3] This acknowledges a tweet by Matthew Kirschenbaum, posted on January 4, 2013: https://twitter.com/mkirschenbaum/status/287280574815666177.

[4] Karen Barad has articulated this while calling for a re-working of the notion of agency in ways that are appropriate to relational ontologies, recognizing agency as a matter of possibilities for reconfiguring entanglements: "the notion that there are agents who have agency, or who grant agency, say, to non-humans (the granting of agency is an ironic notion, no?), pulls us back into the same old humanist orbits over and over again. And it is not easy to resist the gravitational force of humanism, especially when it comes to the question of 'agency.' But agency for me is not something that someone or something has to varying degrees" (Dolphijn and van der Tuin, 54).

[5] We might consider this phenomenon with regard to Bennett's articulation of a vibrant materiality that is "as much force as entity, as much energy as matter, as much intensity as extension" (20).

[6] See, for example Sengers et al.

[7] See Dolphijn and van der Tuin (50).

[8] See https://twitter.com/palaeofuturist/status/622075367898107908.