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How We Think

Digital Media and Contemporary Technogenesis

How do we think? This book explores the proposition that we think through, with, and alongside media. This, of course, is not a new idea. Marshall McLuhan, Friedrich Kittler, Lev Manovich, Mark Hansen, and a host of others have made similar claims. Building on their work, this book charts the implications of media upheavals within the humanities and qualitative social sciences as traditionally print-based disciplines such as literature, history, philosophy, religion, and art history move into digital media. While the sciences and quantitative social sciences have already made this transition, the humanities and qualitative social sciences are only now facing a paradigm shift in which digital research and publication can no longer be ignored. Starting from mind-sets formed by print, nurtured by print, and enabled and constrained by print, humanities scholars are confronting the differences that digital media make in every aspect of humanistic inquiry, including conceptualizing projects, implementing research programs, designing curricula, and educating

students. The Age of Print is passing,¹ and the assumptions, presuppositions, and practices associated with it are now becoming visible as media-specific practices rather than the largely invisible status quo.

To evaluate the impact of digital technologies, we may consider in overview an escalating series of effects. At the lower levels are e-mail, departmental websites, web searches, text messaging, creating digital files, saving and disseminating them, and so forth. Nearly everyone in academia, and large numbers outside academia, participate in digital technologies at these levels. Even here, the effects are not negligible. For example, the patterns of errors in writing made with pen and/or typewriter are quite different from those made with word processing. More dramatic is the impact on academic research; whereas scholars used to haunt the library, nowadays they are likely to access the sources they need via web searches. Perhaps most significant at this level is the feeling one has that the world is at one's fingertips. The ability to access and retrieve information on a global scale has a significant impact on how one thinks about one's place in the world. I live in a small town in North Carolina, but thanks to the web, I do not feel in the least isolated. I can access national news, compare it to international coverage, find arcane sources, look up information to fact-check a claim, and a host of other activities that would have taken days in the pre-Internet era instead of minutes, if indeed they could be done at all. Conversely, when my computer goes down or my Internet connection fails, I feel lost, disoriented, unable to work—in fact, I feel as if my hands have been amputated (perhaps recalling Marshall McLuhan's claim that media function as prostheses). Such feelings, which are widespread,² constitute nothing less than a change in worldview.

Moreover, research indicates that the small habitual actions associated with web interactions—clicking the mouse, moving a cursor, etc.—may be extraordinarily effective in retraining (or more accurately, repurposing) our neural circuitry, so that the changes are not only psychological but physical as well. Learning to read has been shown to result in significant changes in brain functioning; so has learning to read differently, for example by performing Google searches. Nicholas Carr in *The Shallows: What the Internet Is Doing to Our Brains* (2010) argues that these changes are imperiling our ability to concentrate, leading to superficial thought, diminished capacity to understand complex texts, and a general decline in intellectual capacity. He relates them to feelings of being constantly distracted, so that instead of focusing on a task for a relatively long time, one feels compelled to check e-mail, search the web, break off to play a computer game, and so forth. These issues are discussed in chapter 3, but here I want to draw a somewhat

different implication: our interactions with digital media are embodied, and they have bodily effects at the physical level. Similarly, the actions of computers are also embodied, although in a very different manner than with humans. The more one works with digital technologies, the more one comes to appreciate the capacity of networked and programmable machines to carry out sophisticated cognitive tasks, and the more the keyboard comes to seem an extension of one's thoughts rather than an external device on which one types. Embodiment then takes the form of extended cognition, in which human agency and thought are enmeshed within larger networks that extend beyond the desktop computer into the environment. For this reason, models of embodied and extended cognition, such as proposed by Andy Clark (2008) and others, play a central role in my argument.

So far I have been speaking of lower levels of engagement, carried out every day by millions of people. Scholars are among those who frequently enact more sophisticated activities in digital media. At the next level, a scholar begins to use digital technologies as part of the research process. At first this may take the form of displaying results already achieved through other media, for example, posting an essay composed for print on the web. Here the main advantages are worldwide dissemination to a wide variety of audiences, in many cases far beyond what print can reach. The open secret about humanities print publications is their extremely low subscription rates and, beyond this, the shockingly small rate at which articles are cited (and presumably read). David P. Hamilton (1990, 1991) undertook a study of how often journal articles are cited within five years of their publication. Correcting for announcements, reviews, etc., that are not intended for citation (see Pendlebury 1991), his results show that for the sciences, the percentage of articles that have never been cited once in five years is 22.4 percent. For the humanities, it is a whopping 93.1 percent. Even acknowledging the different roles that article publication plays in the sciences (where it is the norm) and the humanities (where the book is the norm) and the different rates at which journal publication takes place in the two fields (a few months in the sciences, from one to three years in the humanities), this figure should give us pause.

The low citation rate suggests that journal publication may serve as a credentialing mechanism for tenure and promotion but that journal publication (with a few significant exceptions) has a negligible audience and a nugatory communicative function. It also raises questions about evaluations of quality. Typically, judgments are made through faculty committees that read a scholar's work and summarize their evaluations for the department. In such

deliberations, questions of outreach and audience are rarely entertained in a negative sense (although they are typically considered when work is deemed influential). If influence and audience were considered, one might make a strong argument for taking into account well-written, well-researched blogs that have audiences in the thousands or hundreds of thousands, in contrast to print books and articles that have audiences in the dozens or low hundreds—if that. Indeed, it should make us rethink credentialing in general, as Gary Hall points out in *Digitize This Book! The Politics of New Media or Why We Need Open Access Now* (2008): “The digital model of publishing raises fundamental questions for what scholarly publishing (and teaching) actually is; in doing so it not only poses a threat to the traditional academic hierarchies, but also tells us something about the practices of academic legitimation, authority, judgment, accreditation, and institution in general” (70).

The next step in engagement comes with conceptualizing and implementing research projects in digital media. Here a spectrum of possibilities unfolds: at one end, a one-off project that a scholar undertakes without becoming deeply engaged and, at the other end, scholars who work primarily in digital media. Even at the lower end of the spectrum, assumptions and presuppositions begin to shift in dramatic ways. For example, the scholar who works in digital media is likely to store data in databases rather than express it discursively. As chapter 2 discusses, this change leads to a significant transformation in how a scholar thinks about her material. Refractory elements that must be subordinated in verbal presentation for an argument to make sense and be compelling can now be given weight in their own right. Constructing a database also makes it possible for different scholars (or teams of scholars) to create different front-ends for the same data, thus encouraging collaboration in data collection, storing, and analysis.

At this point the changes accelerate, for now the digital-based scholar begins to shift her perspective more substantially, as issues of design, navigation, graphics, animation, and their integration with concepts come to the fore. While navigation in print is highly constrained, guided by tables of contents, chapter headings, endnotes, indexes, and so on, in web research navigation may occur in a wide variety of ways, each of which has implications for how the audience will encounter and assess the research and thus for what the research is taken to mean. Hypertext links, hierarchies of screen displays, home page tabs, and so forth all contribute to the overall effect. Graphics, animation, design, video, and sound acquire argumentative force and become part of the research's quest for meaning. As a scholar confronts these issues, sooner or later she will likely encounter the limits of

her own knowledge and skills and recognize the need—indeed, the necessity—for collaboration. Since the best collaborations are those in which all the partners are in from the beginning and participate in the project's conceptualization as well as implementation, this in turn implies a very different model of work than the typical procedures of a print-based scholar, who may cooperate with others in a variety of ways, from citing other scholars to asking acquaintances to read manuscripts, but who typically composes alone rather than in a team environment.

Working collaboratively, the digitally based scholar is apt to enlist students in the project, and this leads quickly to conceptualizing courses in which web projects constitute an integral part of the work. Now the changes radiate out from an individual research project into curricular transformation and, not coincidentally, into different physical arrangements of instruction and research space. The classroom is no longer sufficient for the needs of web pedagogy; needed are flexible laboratory spaces in which teams can work collaboratively, as well as studio spaces with high-end technologies for production and implementation. At this point, it is difficult to say where the transformations end, for now almost every aspect of work in the humanities can be envisioned differently, including research and publication, teaching and mentoring, credentialing and peer evaluation, and last but not least, relations of the academy to the larger society.

Such wide-ranging shifts in perspective often are most dramatically evident in scholars who have administrative responsibility, represented in this study (discussed in chapter 2) by Kenneth Knoespel at Georgia Tech; Tara McPherson at the University of Southern California; Alan Liu at the University of California, Santa Barbara; Harold Short at King's College London; and Jeffrey Schnapp (who was at Stanford University when I interviewed him but has since moved to Harvard University). As administrators, they must necessarily think programmatically about where their administrative units are going, how present trends point to future possibilities, how outcomes will be judged, and how their units relate to the university and the society in general. They clearly understand that digital technologies, in broad view, imply transformation not only of the humanities but of the entire educational system. They are also keenly aware of difficulties to be negotiated within the humanities as traditionally print-based disciplines fracture into diverse contingents, with some scholars still firmly within the regime of print while others are racing into the digital domain.

The changes charted here have been represented as a series of levels with gradual increases between them. However, if the lowest level is compared

directly with the highest, the differences are stark, pointing to the possibility of a widening rift between print- and digital-based scholars. This situation poses a host of theoretical, organizational, and pedagogical challenges. As the Digital Humanities mature, scholars working within digital media are developing vocabularies, rhetorics, and knowledge bases necessary for the advancement of the field. To a certain extent, knowledge construction is cumulative, and the citations, allusions, and specialized discourses of the Digital Humanities presume audiences capable of contextualizing and understanding the stakes of an argument; the implications of a project; the innovations, resistances, and disruptions that research strategies pose to work that has gone before. At the same time, however, traditional (i.e., print-based) scholars are struggling to grasp the implications of this work and often failing to do so.

The failures are apt to take two distinct but related forms. First, print-based scholars are inclined to think that the media upheavals caused by the advent of digital technologies are no big deal. In this view, digital text is read as if it were print, an assumption encouraged by the fact that both books and computer screens are held at about the same distance from the eyes. Moreover, print-based scholars increasingly compose, edit, and disseminate files in digital form without worrying too much about how digital text differs from print, so they tend not to see the ways in which digital text, although superficially similar to print, differs profoundly in its internal structures, as well as in the different functionalities, protocols, and communicative possibilities of networked and programmable machines. The second kind of failure manifests as resistance to, or outright rejection of, work in digital media. Many factors are implicated in these responses, ranging from anxieties that (print) skill sets laboriously acquired over years of effort may become obsolete, to judgments formed by print aesthetics that undervalue and underrate digital work, leading to a kind of tunnel vision that focuses on text to the exclusion of everything else such as graphics, animation, navigation, etc.

Faced with these resistances and misunderstandings, humanities scholars working in digital media increasingly feel that they are confronted with an unsavory dilemma: either they keep trying to explain to their print-based colleagues the nature and significance of their work, fighting rearguard actions over and over at the expense of developing their own practices, or else they give up on this venture, cease trying to communicate meaningfully, and go their own way. The resulting rift between print-based and digital scholarship would have significant implications for both sides. Print-based scholars would become increasingly marginalized, unable to communicate not only

with Digital Humanities colleagues but also with researchers in the social sciences and sciences, who routinely use digital media and have developed a wide range of skills to work in them. Digital humanities would become cut off from the rich resources of print traditions, leaving behind millennia of thought, expression, and practice that no longer seem relevant to its concerns.

Surely there must be a better way. Needed are approaches that can locate digital work within print traditions, and print traditions within digital media, without obscuring or failing to account for the differences between them. One such approach is advocated here: it goes by the name of Comparative Media Studies.³ As a concept, Comparative Media Studies has long inhabited the humanities, including comparisons of manuscript and print cultures, oral versus literate cultures, papyri versus vellum, immobile type versus moveable type, letterpress versus offset printing, etc. These fields have tended to exist at the margins of literary culture, of interest to specialists but (with significant exceptions) rarely sweeping the humanities as a whole. Moreover, they have occupied separate niches without overall theoretical and conceptual frameworks within which Comparative Media Studies might evolve.

With the momentous shift from print to digital media within the humanities, Comparative Media Studies provides a rubric within which the interests of print-based and digital humanities scholars can come together to explore synergies between print and digital media, at the same time bringing into view other versions of Comparative Media Studies, such as the transition from manuscript to print culture, that have until now been relegated to specialized subfields. Building on important work in textual and bibliographic studies, it emphasizes the importance of materiality in media. Broadening the purview beyond print, it provides a unifying framework within which curricula may be designed systematically to initiate students into media regimes, highlighting the different kinds of reading practices, literacies, and communities prominent in various media epochs.

Examples of Comparative Media Studies include research that combines print and digital literary productions, such as Matthew Kirschenbaum's (2007) concepts of formal and forensic materiality, Loss Glazier's (2008) work on experimental poetics, John Cayley (2004, 2002) on letters and bits, and Stephanie Strickland (Strickland 2002; Strickland and Lawson 2002) on works that have both print and digital manifestations. Other examples are theoretical approaches that combine continental philosophy with New Media content, such as Mark Hansen's *New Philosophy for New Media* (2006b).

Still others are provided by the MIT series on platform studies, codirected by Nick Montfort and Ian Bogost (Montfort and Bogost 2009), which aims to locate specific effects in the affordances and constraints of media platforms such as the Atari 5600 video game system, in which the techniques of close reading are applied to code and video display rather than text. Also in this grouping are critical code studies, initiated by Wendy Hui Kyong Chun (2008, 2011) and Mark Marino (2006) among others, that bring ideology critique to the rhetoric, form, and procedures of software. In this vein as well is Ian Bogost's work (2007) on procedural rhetorics, combining traditional rhetorical vocabularies and approaches with software functionalities. Lev Manovich's recent (2007) initiative, undertaken with Jeremy Douglas, on "cultural analytics" uses statistical analysis and database structures to analyze large data sets of visual print materials, such as *Time* covers from 1923 to 1989, and one million pages of manga graphic novels (discussed in chapter 3). Diverse as these projects are, they share an assumption that techniques, knowledges, and theories developed within print traditions can synergistically combine with digital productions to produce and catalyze new kinds of knowledge.

On a pedagogical level, Comparative Media Studies implies course designs that strive to break the transparency of print and denaturalize it by comparing it with other media forms. Alan Liu (2008c) at the University of California, Santa Barbara, has devised a series of courses that he calls "Literature+" (discussed in chapter 3), which combines close reading of print texts with comparisons to other media forms. Another example is a seminar comparing the transition from manuscript to print with that of print to digital, offered at Yale University by Jessica Brantley, a medievalist, and Jessica Pressman, a specialist in contemporary literature. Other approaches might stress multiple literacies that include print but also emphasize writing for the web, designing computer games, creating simulations of social situations, and a variety of other media modalities. My colleagues at Duke University, including Cathy Davidson, Nicholas Gessler, Mark Hansen, Timothy Lenoir, and Victoria Szabo, are creating courses and research projects that follow such interdisciplinary lines of inquiry. Extrapolating from these kinds of experiments, Comparative Media Studies can provide a framework for courses in which students would acquire a wide repertoire of strategies to address complex problems. Faced with a particular kind of problem, they would not be confined to only one mode of address but could think creatively about the resources, approaches, and strategies the problem requires and choose the

more promising one, or an appropriate combination of two or more, for a given context.

Such a curriculum is worlds away from the offerings of a traditional English department, which typically focuses on periodizations (e.g., eighteenth century prose), nationalities (British, American, Anglophone, etc.), and genres (fiction, prose, drama). The difficulties with this kind of approach are not only that it is outmoded and fails to account for what much of contemporary scholarship is about (postcolonial studies, globalization studies, race and gender studies, etc.). It also focuses on content rather than problems, assuming that students will somehow make the leap from classroom exercises to real-world complexities by themselves. To be sure, not every intellectual exercise may be framed as a problem. The humanities have specialized in education that aims at enriching a student's sense of the specificity and complexity of our intellectual heritage, including major philosophical texts, complex literary works, and the intricate structures of theoretical investigations into language, society, and the human psyche. Nevertheless, there must also be a place for problem-based inquiry within the humanities as well as the sciences and social sciences. Comparative Media Studies is well suited to this role and can approach it through the framework of multiple literacies.

The implications of moving from content orientation to problem orientation are profound. Project-based research, typical of work in the Digital Humanities, joins theory and practice through the productive work of making. Moreover, the projects themselves evolve within collaborative environments in which research and teaching blend with one another in the context of teams with many different kinds of skills, typically in spaces fluidly configured as integrated classroom, laboratory, and studio spaces. The challenges of production complicate and extend the traditional challenges of reading and writing well, adding other dimensions of software utilization, analytical and statistical tools, database designs, and other modalities intrinsic to work in digital media. Without abandoning print literacy, Comparative Media Studies enriches it through judicious comparison with other media, so that print is no longer the default mode into which one falls without much thought about alternatives but rather an informed choice made with full awareness of its possibilities and limitations. Conceptualized in this way, Comparative Media Studies courses would have wide appeal not only within the humanities but in the social sciences and some of the hard sciences as well. Such courses would provide essential preparation for students

entering the information-intensive and media-rich environments in which their careers will be forged and their lives lived.

Adopting this perspective requires rethinking priorities and assumptions on so many levels that it is more like peeling an onion than arriving at a decision. One thinks one understands the implications, but then further layers reveal themselves and present new challenges to the scholar who has grown up with print, taught with print, and conducted research exclusively in print media. A principal aim of this book is to excavate these layers, showing through specific case studies what Comparative Media Studies involves. One way into the complexities is to track the evolution of the Digital Humanities, the site within the humanities where the changes are most apparent and, arguably, most disruptive to the status quo. As chapter 2 shows, the Digital Humanities are not a monolithic field but rather a collection of dynamic evolving practices, with internal disputes, an emerging set of theoretical concerns interwoven with diverse practices, and contextual solutions to specific institutional configurations.

Another way is through the concept of technogenesis, the idea that humans and technics have coevolved together. The proposition that humans coevolved with the development and transport of tools is not considered especially controversial among paleoanthropologists. For example, the view that bipedalism coevolved with tool manufacture and transport is widely accepted. Walking on two legs freed the hands, and the resulting facility with tools bestowed such strong adaptive advantage that the development of bipedalism was further accelerated, in a recursive upward spiral that Andy Clark (2008) calls “continuous reciprocal causation.” To adapt this idea to the contemporary moment, two modifications are necessary. The first was proposed in the late nineteenth century by James Mark Baldwin (1896), now referred to as the Baldwin effect. He suggested that when a genetic mutation occurs, its spread through a population is accelerated when the species reengineers its environment in ways that make the mutation more adaptive. Updating Baldwin, recent work in evolutionary biology has acknowledged the importance of epigenetic changes—changes initiated and transmitted through the environment rather than through the genetic code. This allows for a second modification, the idea that epigenetic changes in human biology can be accelerated by changes in the environment that make them even more adaptive, which leads to further epigenetic changes. Because the dynamic involves causation that operates through epigenetic changes, which occur much faster than genetic mutations, evolution can now happen much faster, especially in environments that are rapidly transforming with multi-

ple factors pushing in similar directions. Lending credence to this hypothesis is recent work in neurophysiology, neurology, and cognitive science, which has shown that the brain, central nervous system, and peripheral nervous system are endowed with a high degree of neural plasticity. While greatest in infants, children, and young people, neural plasticity continues to some extent into adulthood and even into old age.

As digital media, including networked and programmable desktop stations, mobile devices, and other computational media embedded in the environment, become more pervasive, they push us in the direction of faster communication, more intense and varied information streams, more integration of humans and intelligent machines, and more interactions of language with code. These environmental changes have significant neurological consequences, many of which are now becoming evident in young people and to a lesser degree in almost everyone who interacts with digital media on a regular basis.

The epigenetic changes associated with digital technologies are explored in chapter 3 through the interrelated topics of reading and attention. Learning to read complex texts (i.e., “close reading”) has long been seen as the special province of the humanities, and humanities scholars pride themselves on knowing how to do it well and how to teach students to do it. With the advent of digital media, other modes of reading are claiming an increasing share of what counts as “literacy,” including hyper reading and analysis through machine algorithms (“machine reading”). Hyper reading, often associated with reading on the web, has also been shown to bring about cognitive and morphological changes in the brain. Young people are at the leading edge of these changes, but pedagogical strategies have not to date generally been fashioned to take advantage of these changes. Students read and write print texts in the classroom and consume and create digital texts of their own on screens (with computers, iPhones, tablets, etc.), but there is little transfer from leisure activities to classroom instruction or vice versa. A Comparative Media Studies perspective can result in courses and curricula that recognize all three reading modalities—close, hyper-, and machine—and prepare students to understand the limitations and affordances of each.

Fred Brooks, a computer scientist at the University of North Carolina and author of the best-selling *The Mythical Man-Month* (alluding to the flawed assumption that more manpower inevitably means faster progress), offers good advice relevant to crafting a Comparative Media Studies approach in *The Design of Design: Essays from a Computer Scientist* (2010a). In an interview

in *Wired*, he comments that “the critical thing about the design process is to identify your scarcest resource. Despite what you may think, that very often is not money. For example, in a NASA moon shot, money is abundant but lightness is scarce; every ounce of weight requires tons of material below. On the design of a beach vacation home, the limitation may be your ocean-front footage. You have to make sure your whole team understands what scarce resource you’re optimizing” (2010b:92). The answer to the “scarce resource” question for societies in developed countries seems clear: the sheer onslaught of information has created a situation in which the limiting factor is human attention. There is too much to attend to and too little time to do it. (The situation is of course quite different in developing countries, where money may indeed function as the scarce resource.)

Hyper reading, which includes skimming, scanning, fragmenting, and juxtaposing texts, is a strategic response to an information-intensive environment, aiming to conserve attention by quickly identifying relevant information, so that only relatively few portions of a given text are actually read. Hyper reading correlates, I suggest, with hyper attention, a cognitive mode that has a low threshold for boredom, alternates flexibly between different information streams, and prefers a high level of stimulation. Close reading, by contrast, correlates with deep attention, the cognitive mode traditionally associated with the humanities that prefers a single information stream, focuses on a single cultural object for a relatively long time, and has a high tolerance for boredom. These correlations suggest the need for pedagogical strategies that recognize the strengths and limitations of each cognitive mode; by implication, they underscore the necessity for building bridges between them. Chapter 3, where these matters are discussed, begins weaving the thread of attention/distraction that runs throughout the book. If we think about humanities research and teaching as problems in design (i.e., moving from content orientation to problem orientation), then Brooks’s advice suggests that for collaborative teams working together to craft projects and curricula in digital media, it is crucial for team partners to recognize the importance of human attention as a limiting/enabling factor, both as a design strategy and as a conceptual framework for theoretical work. In an academic context, of course, the issue is not as simple as optimization, for pedagogical goals and research projects may aim at disruption and subversion rather than replication. This caveat notwithstanding, attention as a focus for inquiry opens onto a complex and urgent set of issues, including the relation of human to machine cognition and the cycles of epigenetic changes catalyzed by our increasing exposure to and engagement with digital media.

To flesh out the concept of technogenesis and to explore how a technology platform can initiate wide-ranging changes in society, chapter 5 undertakes a case study of the first globally pervasive binary signaling system, the telegraph. The focus is on telegraph code books, print productions that offered “economy, secrecy and simplicity” by matching natural-language phrases with corresponding code words. Affecting the wider society through the changes that telegraphy catalyzed, telegraph code books demonstrate that changed relations of language and code, bodily practices and technocratic regimes, and messages and cultural imaginaries created technogenetic feedback loops that, over the course of a century, contributed significantly to reengineering the conditions of everyday life. In this sense, telegraphy anticipated the epigenetic changes associated with digital technologies, especially fast communication and the virtualization of commodities.

When humanities scholars turn to digital media, they confront technologies that operate on vastly different time scales, and in significantly different cognitive modes, than human understanding. Grasping the complex ways in which the time scales of human cognition interact with those of intelligent machines requires a theoretical framework in which objects are seen not as static entities that, once created, remain the same throughout time but rather are understood as constantly changing assemblages in which inequalities and inefficiencies in their operations drive them toward breakdown, disruption, innovation, and change. Objects in this view are more like technical individuals enmeshed in networks of social, economic, and technological relations, some of which are human, some nonhuman. Among those who have theorized technical objects in this way are Gilbert Simondon, Adrian Mackenzie, Bruno Latour, and Matthew Fuller. Building on their work, I hypothesize in chapter 4 about the multilevel, multiagent interactions occurring across the radically different time scales in which human and machine cognitions intermesh: on the human side, the very short time scales of synaptic connections to the relatively long time scales required for narrative comprehension; on the machine side, the very fast processing at the level of logic gates and bit reading to the relatively long load times of complex programs. Obviously, the meshing of these two different kinds of complex temporalities does not happen all at one time (or all at one place) but rather evolves as a complex syncopation between conscious and unconscious perceptions for humans, and the integration of surface displays and algorithmic procedures for machines. The interactions are dynamic and continuous, with feedback and feedforward loops connecting different levels with each other and cross-connecting machine processes with human responses.

On the level of conscious thought, attention comes into play as a focusing action that codetermines what we call materiality. That is, attention selects from the vast (essentially infinite) repertoire of physical attributes some characteristics for notice, and they in turn constitute an object's materiality. Materiality, like the object itself, is not a pre-given entity but rather a dynamic process that changes as the focus of attention shifts. Perceptions exist unconsciously as well as consciously, and research emerging from contemporary neuroscience, psychology, and other fields about the "new unconscious" (or "adaptive unconscious") plays a critical role in understanding this phenomenon. In these views, the unconscious does not exist primarily as repressed or suppressed material but rather as a perceptive capacity that catches the abundant overflow too varied, rich, and deep to make it through the bottleneck of attention. Attention, as the limiting scarce resource, directs conscious notice, but it is far from the whole of cognitive activity and in fact constitutes a rather small percentage of cognition as a whole. The realization that neural plasticity happens at many levels, including unconscious perceptions, makes technogenesis a potent site for constructive interventions in the humanities as they increasingly turn to digital technologies. Comparative Media Studies, with its foregrounding of media technologies in comparative contexts, provides theoretical, conceptual, and practical frameworks for critically assessing technogenetic changes and devising strategies to help guide them in socially constructive ways.

If time is deeply involved with the productions of digital media, so too is space. GIS (geographic information system) mapping, GPS (global positioning system) technologies, and their connections with networked and programmable machines have created a culture of spatial exploration in digital media. At least as far back as Henri Lefebvre's *The Production of Space* ([1974] 1992), contemporary geographers have thought about space not in static Cartesian terms (which Lefebvre calls represented or conceived space) but as produced through networks of social interactions. As Lefebvre proclaims, (social) practices produce (social) spaces. Among contemporary geographers, Doreen Massey (1994a, 1994b, 2005) stands out for the depth of her research and intelligent advocacy of an approach to social spaces based on interrelationality, open-ended temporality, and a refusal of space represented as a Cartesian grid. For spatial history projects, however, georeferencing relational databases to the "absolute space" of inches, miles, and kilometers has proven unavoidable and indeed desirable, since it allows interoperability with the data sets and databases of other researchers. The tensions between Massey's dream (as it is called in chapter 6) and the spatial history projects

exemplified by the Stanford Spatial History Project show the limitations as well as the theoretical force of Massey's approach.

The inclusion of databases in spatial history projects has opened the door to new strategies that, rather than using narrative as their primary mode of explication, allow flexible interactions between different layers and overlays. As a result, explanations move from charting linear chains of causes and effects to more complex interactions among and between networks located in space and time. Moreover, historical projects have also moved from relational databases, in which data elements are coordinated through shared keys (i.e., common data elements), to object-oriented databases, in which classes possess inheritable traits and aggregative potentials. As Michael Goodchild (2008) explains, the older relational model implies a metaphor of GIS as a container of maps. One constructs a map by merging different data elements into a common layer. While this strategy works well for certain kinds of explanations, it has the disadvantage of storing data in multiple databases and creating spatial displays that have difficulty showing change through time. Newer object-oriented databases, by contrast, imply a metaphor of objects in the world that can spawn progeny with inherited traits, merge with other objects, and aggregate into groups. This makes it possible to chart their movements through time in ways that make time an intrinsic property rather than something added on at the end by marking layers with time indicators.

Whereas historical and historically inflected projects are finding new ways to construct and display social space, experimental literature plays with the construction of imaginary spaces. Chapter 7 explores Steven Hall's distributed literary system that has as its main component the print novel *The Raw Shark Texts: A Novel* ([2007] 2008a). In depicting a posthuman subjectivity that has transformed into a huge online database capable of evacuating individual subjectivities and turning them into "node bodies," the text performs a critique of postindustrial knowledge work as analyzed by Alan Liu (2008b). In the print text, the distance between signifier and signified collapses, so that letters form not only words but also objects and living beings. In the "unspace" of abandoned tunnels, warehouses, and cellars, the story evolves of amnesiac Eric Sanderson's search for his past memories while he is pursued by a "conceptual shark," the Lodovician, which hunts him through the trails of thoughts, perceptions, and memories that he emits. While social space is constructed through social practices, "unspace" is constructed through words that at once signify and function as material objects. The materiality of language is here given a literal interpretation, and the

resulting conflation of imaginary with physical space creates an alternative universe mapped as well as denoted by language. Supremely conscious of itself as a print production, this book explores the linguistic pleasures and dangerous seductions of immersive fictions, while at the same time exploring the possibilities for extending its narrative into transmedial productions at Internet sites, translations into other languages, and physical locations.

With the advent of digital databases and the movement of traditionally narrative fields such as qualitative history into new kinds of explanations and new modes of data displays, narrative literature has fashioned its own responses to information-intensive environments. As Lev Manovich has noted, narrative and database have complementary strengths and limitations (2002:190–212). Narrative excels in constructing causal models, exploiting complex temporalities, and creating models of how (other) minds work. Databases, by contrast, specialize in organizing data into types and enabling the flexible concatenation of data elements. In an era when databases are perhaps the dominant cultural form, it is no surprise that writers are on the one hand resisting databases, as *The Raw Shark Texts* (2008e) does, and on the other hand experimenting with ways to combine narrative and database into new kinds of literature, as does Mark Z. Danielewski's *Only Revolutions* (2007b). Part epic poem, part chronological database of historical events, *Only Revolutions* pushes the envelope of literary forms that may still be called “a novel.”

One of the ways in which *Only Revolutions* works, discussed in chapter 8, is through the application of an extensive set of constraints, mirroring in this respect the structured forms of relational databases and database queries. Whereas relational databases allow multiple ways to concatenate data elements, the spatial aesthetic of *Only Revolutions* creates multiple ways to read every page spread by dividing the page into clearly delineated sections that can be cross-correlated. Moreover, an invisible constraint governs the discourse of the entire text—Danielewski's previous novel *House of Leaves* (2000), which functions as a mirror opposite to *Only Revolutions*. Whatever was emphasized in *House of Leaves* is forbidden to appear in *Only Revolutions*, so that what cannot be spoken or written becomes a powerful force in determining what is written or spoken. In this sense, *Only Revolutions* posits an Other to itself that suggests two responses to the information explosion: a novel that attempts to incorporate all different kinds of discourses, sign systems, and information into itself, engorging itself in a frenzy of graphomania (i.e., *House of Leaves*) and a novel that operates through severe constraints, as if keeping the information deluge at bay through carefully constructed

dikes and levees (i.e., *Only Revolutions*). In the first case, attention is taxed to the limit through writing strategies that fill and overfill the pages; in the second case, attention is spread among different textual modalities, each interacting with and constraining what is possible in the others.

In conclusion, I offer a few reflections on my book title and on the book as itself a technogenetic intervention. *How We Think* encompasses a diverse sense of “we,” focusing in particular on the differences and overlaps between the perspectives of print-based and digital-based scholars in the humanities and qualitative social sciences. “Think”—a loaded word if ever there was one—implies in this context both conscious and unconscious perceptions, as well human and machine cognition. Like humans, objects also have their embodiments, and their embodiments matter, no less than for humans. When objects acquire sensors and actuators, it is no exaggeration to say they have an *umwelt*, in the sense that they perceive the world, draw conclusions based on their perceptions, and act on those perceptions.⁴ All this takes place, of course, without consciousness, so their modes of being in the world raise deep questions about the role of consciousness in embodied and extended cognition. The position taken throughout this book is that all cognition is embodied, which is to say that for humans, it exists throughout the body, not only in the neocortex. Moreover, it extends beyond the body’s boundaries in ways that challenge our ability to say where or even if cognitive networks end.

Making the case for technogenesis as a site for constructive interventions, this book performs the three reading strategies discussed in chapter 3 of close, hyper-, and machine reading. The literary texts discussed here provide the occasion for close reading. Since these texts are deeply influenced by digital technologies, they are embedded in information-intensive contexts that require and demand hyper reading, which in conjunction with close reading provided the wide range of references used throughout the book. Finally, the coda to chapter 8, written in collaboration with Allen Riddell, presents results from our machine reading of *Only Revolutions*. Combining close, hyper-, and machine reading with a focus on technogenesis, the book is meant as a proof of concept of the potential of Comparative Media Studies not only in its arguments but also in the methodologies it instantiates and the interpretive strategies it employs.

Momentous transformations associated with digital technologies have been recognized and documented by a plethora of studies discussing economic, social, political, and psychological changes. However, people are the ones driving these changes through myriad decisions about how to use the

technologies. This lesson was clear at the very beginning of the Internet, when users grasped its potential for communication and especially the usefulness of web browsers for expression and display. Every major development since then has been successful not (or not only) because of intrinsic technological capability but because users found ways to employ them to pursue their own interests and goals. Hacktivism, the open source movement, user listservs, music and video file sharing, social networking, political games, and other practices in digital media are user-driven and often user-defined; they are potent forces in transforming digital technologies so that they become more responsive to social and cultural inequities, more sensitive to webs of interconnections between people and between people and objects, more resistant to predatory capitalistic practices. In this view, digital media and contemporary technogenesis constitute a complex adaptive system, with the technologies constantly changing as well as bringing about change in those whose lives are enmeshed with them.

We are now in a period when the interests of individuals are in dynamic interplay with the vested interests of large corporations, sometimes working together to create win-win situations, other times in sharp conflict over whose interests will prevail. Contemporary technogenesis encompasses both possibilities, as well as the spectrum of other outcomes in between; as a phrase, it does not specify the direction or human value of the changes, whether for good or ill. This book takes that ambiguity as its central focus, as it attempts to intervene in locally specific ways in the media upheavals currently in progress by showing how digital media can be used fruitfully to redirect and reinvigorate humanistic inquiry. People—not the technologies in themselves—will decide through action and inaction whether an intervention such as this will be successful. In this sense, my title is as much an open-ended question as an assertion or claim.