# Computational Poetics: An Introduction

While I write these introductory remarks, a ceiling-mounted smoke detector in my kitchen emits a loud noise every three minutes or so. A pleasant female voice announces also “low battery.” This is, I learn, a precaution stipulated by US National Fire Alarm Code 72-108 11.6.6 (2013). The clause requiring a “distinct audible signal before the battery is incapable of operating” is encoded into the device. The smoke detector literally embodies that piece of legislation in its circuitry. We thus obtain a condition where two meanings of code—as governance and machine instruction—coincide. Code equals code.

I am at home, but I also receive a notification of the alarm on my mobile phone. Along with monitoring apps that help make my home “smarter,” the phone contains most of my library. I often pick it up to read a book. The phrase “reading a book,” however, obscures a number of metaphors for a series of odd actions. The “book” is a small, thin black rectangle: three inches wide, five inches tall, and barely a few millimeters thick. A slab of polished glass covers the front of the device, where the tiny eyes of a camera and a light sensor also protrude. At the back, made of smooth soft plastic, we find another, larger camera. At the foot of the device, a grid of small perforations indicates breathing room for a speaker and several microphones. To “open” a book I touch the glass. The machine recognizes my fingerprint. I then tap and poke at the surface until I find a small image that represents both my library and book store, where I can “buy” and “borrow” books. Buying or borrowing books does not, however, involve the possession of physical objects. Rather, I agree to a licence that grants limited access to data, which the software then assembles into something resembling a book on screen. I tap again to begin reading. The screen dims to match room ambiance as it fills up with words. A passage on the first page appears underlined: other readers in my social circle must have found it notable. I swipe across the glass surface to turn a “page.” The device emits a muffled rustle to reinforce the pretense of manipulating paper. The image curls ever so slightly as another “page” slides into view. My tiny library metaphor contains hundreds of such page metaphors.

Despite appearances, the electronic metaphor-making device on my desk has more in common with smoke detectors than it does with several paper volumes scattered on my desk. The electronic book and smoke alarm contain printed circuit boards, capacitors, and resistors. Both draw electric current. Both require firmware updates and both are governed by codes, political and computational. Smoke alarms and mobile phones connect to the internet. They communicate with distant data centers and with each other. Yet, I continue to “read” these devices as if they were familiar, immutable, and passive objects: just books. I think of them as intimate artifacts—friends even—wholly known to me, comforting, and warm. The electronic book is none of those things. Besides prose, it keeps my memories, pictures, words, sounds, and thoughts. It records my reading, sleeping, and consumption habits. It tries to sell me things, showing me advertisements for cars, jewelry, and pills. It comes with a manual and terms of service. It is my confidant, my dealer, my spy.

*Plain Text* concerns the nature of digital inscription—the material trace that gives rise to textual phenomena, and, more broadly, to all cultural artifacts in which computers mediate. We find ourselves today in an unprecedented, since the Middle Ages, position of selective *asemiosis*: the loss of signification. Many contemporary texts—like poems inscribed into bacteria and encrypted software—exist simply beyond the reach of human senses.[[1]](#endnote-2) Other forms of writing are illegible by design, in ways that prevent access or comprehension. Increasingly, we write not in the sense of making marks on paper but in simulation. Key presses leave lasting traces in computer memory, which then appear on screen redoubled and ephemeral. On disk, marks endure in a form legible only to those who possess the specialized tools and training necessary to decipher them.

I appeal to the idea of “plain text” in the title of this book to signal an affinity with a particular mode of computational meaning-making. Plain text identifies a file format and frame of mind. As file format, it contains nothing but a “pure sequence of character codes.” Plain text stands in opposition to “fancy text,” “text representation consisting of plain text plus added information.”[[2]](#endnote-3) In the tradition of American textual criticism, “plain text” alludes to an editorial method of text transcription which is both “faithful to the text of its source” and is “easier to read than the original document.”[[3]](#endnote-4) Combining these two traditions, I mean to build a case for a kind of a systematic minimalism when it comes to our use of computers—a minimalism that privileges access to source materials, ensuring legibility and comprehension. I do so in contrast with other available modes of human-computer interaction, which instead maximize system-centric ideals like efficiency, speed, performance, or security.

The title further identifies an interpretive stance one can assume in relation to the making and the unmaking of literary artifacts. Besides visible content, all contemporary documents carry with them a layer of hidden information. Originally used for typesetting, that layer affects more than innocuous document attributes like “font size” or “line spacing.” Increasingly, devices that mediate literary activity also embody governing structures. For example, the Digital Millennium Copyright act, passed in the United States in 1996, goes beyond written injunction to require in some cases the management of digital rights (DRM) at the level of hardware. An electronic book governed by DRM may subsequently prevent the reader from copying or sharing stored content, even for the purposes of academic study.[[4]](#endnote-5) In some situations, the device may collect reader activity.

Machine instruction thus embodies new forms of technological control. To speak truth to power—to retain a civic potential for critique—we must therefore perceive the mechanisms of its codification. Critical theory cannot otherwise endure apart from material contexts of textual production, which today emanate from the fields of computer science and software engineering. Conversely, a tighter coupling with the critical tradition can reveal technology’s often occluded political implications. To create a novel algorithm that predicts crime by analyzing one’s reading habits, for example, is also to invite the dystopian possibility of thought policing, unless, that is, such algorithms remain legible, in public view, and under continual counter-scrutiny. A vibrant discursive practice of textual exegesis is crucial for the preservation of whatever ideals that demand a literate populace.

## Thesis and Archive

*Plain Text* is a response to a particular situation of a literary scholar encountering the field of software engineering. For a long stretch of my professional life, these two areas of activity remained separate. I worked at one and I studied the other. At the time, I simply did not think that code had much to do with poetry. Initially, my two selves—the scholar and the engineer—spoke different languages. Reconciling them was and continues to be a disconcerting process by which things dear and familiar to me, in both worlds, grew strange and unfamiliar, showing themselves to be sometimes less than, and sometimes more than I comfortably expected. Nothing could be assumed from the start. Field specific language, down to its foundations, had to be examined for hidden assumptions that prevented dialog. With time, I saw that code and poetry have much to do with one another. Writing this book has taught me to embrace the remaining incongruence.

The idea for *Plain Text* came in a moment of realization, after I was asked one of those seemingly naive but fundamental questions that can set research in motion down a long and winding path.

A childhood friend who shares a love for reading asked why he could not lend me a copy of the novel that he recently purchased from a major online retailer.[[5]](#endnote-6) In my struggle to answer, I realized that some of my deepest intuitions about literature relied on assumptions firmly attached to print media. Despite my professional experience as a programmer and academic training in literary studies, I could not readily explain the mechanisms by which electromagnetic charges transformed into pixels and pixels into words. Where to begin? To recount the passage of digital text, one has to know something about chip architecture, operating systems, file permissions, networking, and encryption. I could describe parts of that ecosystem, but my knowledge was also riddled with unexamined gaps. It did not amount to a coherent story.

Worse yet, it quickly became apparent that these technical details affect all higher-level interpretive activity. To read together—to form a shared understanding of a text—we had convene on the same page, which was made difficult in our case by imposed geographic restrictions. The text changed as it passed hands. I now had to draw on philology and sociology of literature to reflect on textual variants, recensions, and authorship attribution. Digital text was more obviously entwined with its reception history: reader reviews and algorithmic recommendation engines. Despite the new copy, it was marked and highlighted. It synchronized with other media like audio books and related television promotions. The work was pre-processed, in both technical and social senses of the word, to privilege certain meanings and modes of comprehension.

The task of “coming to terms” with these emergent contingencies entails an expansive research program, that could only be commenced here in part. The digital literary ecosystem is evolving rapidly. A historical approach to its development extrapolates its trajectory into the future. Crucially, digital knowledge ecologies are only coming into being; they are still pliable, still in their formative state. Their cultural importance necessitates active commentary and experimentation. Without it, we risk the dominion of what Langdon Winner has called “autonomous technology”—a condition by which complex systems begin to irrevocably determine our politics. “Modern people have filled the world with the most remarkable array of contrivances,” Winner wrote. We are then surprised to find them resistant to change. “The human kind faces a woefully permanent bondage to the power of its own inventions,” he concluded. And I hope, along with him, that it is still possible to “reconsider and reconstruct” those outcrops that in retrospect impoverish culture, to “learn and start again,” and to retain the “prospect of liberation.”[[6]](#endnote-7)

To these ends, *Plain Text* tells a story of a major morphological shift affecting cultural production, particularly as it relates to the mechanics of writing. Were I to interrupt a digital typist to ask—Where do these words reside?—I would likely receive several conflicting answers in response. In some sense, the words are on screen, where they appear to view. In another sense, they are somewhere within the machine, on remote and hermeneutically sealed surfaces: silicone chips, hard drives, flash memory cards. Yet in another sense, visible signs are still further removed from the contexts of their production. The word is in the wires. It spreads across servers, routers, and data centers. What was once apparent now takes on a more complex structure, stretched across planes and temporalities. The book—this book, any book—gains a new shape. Digital texts form a live lattice—a multidimensional grid—which connects the letter’s tactile response, at one’s fingertips, to its optic and electromagnetic traces. In aggregate, these *laminates* incorporate the scaffolding of synthetic inscription. I cannot consequently pass a digital note to another, in the same sense that one passes notes in class, on paper. It is impossible to give the entire structure over. Text is irrevocably intertwined with its stratified material contexts. It means—it *becomes*—something else when recreated under conditions not fully congruent to my own.

Much contemporary anxiety about the intrusion of computational culture into the everyday can be traced to such fundamental reshaping of the sign. Its fracture leads to its multivalence. The lattice expands into spaces between signs, where forces of capital and control intervene to monitor and monetize.[[7]](#endnote-8) Many are vaguely aware that they no longer read or write alone. Who shares the page? What forces contest that space for thought? In this book we will confront the technological other, if not to answer such questions, but to know where to look for answers.

Reflecting on the development of Morse Code in 1949 in the *Proceedings of the American Philosophical Society*, Frank Halstead mentioned the difficulty of finding a home in either the arts or sciences for what he called “code development.” “It is a matter somewhat related to the general art of cryptology,” he wrote, “yet it is not wholly divorced from electrical engineering nor from general philology.”[[8]](#endnote-9) As Halstead anticipated, research into codification has led me to a rich multidisciplinary archive of materials from the history of literary theory, semiotics, telegraphy, and electrical engineering from the middle of the nineteenth to the end of the twentieth century. That archive includes patents and technical manuals, formalist manifestos, studies of animal communication, human-computer interaction textbooks, as well as foundational texts in aesthetics and literary theory.

I deploy the archive to argue that extant theories of interpretation evolved under conditions tied to static print media. By contrast, digital text changes dynamically to suit its reader, political context, and geography. Consequently, I advocate for the development of *computational poetics*: a strategy of interpretation capable of reaching past surface content to reveal platforms and infrastructures that stage the construction of meaning. Where “distant reading” and cultural analytics perceive patterns across large-scale corpora, computational poetics breaks textuality down into its minute constituent components. It is a strategy of micro- rather than macro-analysis.[[9]](#endnote-10)

In *Plain Text*, I will also argue that some of contemporary public sphere’s ideological afflictions—the acquiescence to routine surveillance and censorship, for example—relate to our failure as readers and writers to come to terms with the changing material conditions of digital text. A society that cares about the long-term preservation of complex discursive formations like free speech, privacy, or online deliberation, would do well to take heed of the textual building blocks at their foundation. The structure of discursive formation—documents and narratives—has long been at the center of both computer science and literary theory. Using primary sources from both disciplines, *Plain Text* uncovers the shared history of literary machines, bringing computation closer to its humanistic roots, and the humanities closer to its computational realities.

The book makes a historical case for the recovery of textual thought latent in the machinery of contemporary computing. Just as literary scholarship cannot survive without awareness of its computational present, the design of computational platforms cannot advance without greater awareness of its cultural contexts. The political struggle for meaning-making, the very opportunity to engage in the act of interpretation, thus begins and ends with the material affordances of the epistemic artifact.[[10]](#endnote-11)

The future of reading and writing is inexorably intertwined with the development of computer science and software engineering. Even if you are not reading these words on a screen, my message has reached you through a long chain of machine-mediated transformations: from the mechanical action of the keyboard on which I am now typing, to the arrangement of electrons on magnetic storage media, to the modulation of fiber-optic signal, to the shimmer of the flowing liquid crystal display rendering the text. Computation occupies the space between keyboard and screen, which in turn gives rise to higher-order cultural institutions: from the architecture of social media platforms to the formation of massive shared archives. “Cultural techniques” that guide our use of such technologies are formative of the society as a whole.[[11]](#endnote-12) Daily choices like choosing a text editor, a filing system, or a social networking platform cannot therefore be addressed in shallow instrumental, system-centric ideals. Complex computational systems cannot give rise to ideals any more than financial markets can. From the many available visions of human-computer interaction I argue for choosing one that confirms to a humanist ethos, whatever the reader’s politics.

## Theory

### *Displacement*

*Plain Text* is ultimately an exploration of textual space.[[12]](#endnote-13) It is thus inherently concerned with the dynamics of settlement and displacement, which frame the book’s historical argument and form its theoretical underpinnings.

I mean settlement in the way one lives among and within one’s own notebooks, bookshelves, and archives. Smart toasters and electronic heart valves are distinct from their dumb mechanical counterparts in that they similarly give grounds to inscription. Computers are machines that need to perform reading and writing operations at scale. To support that activity, they necessarily found vast, in terms of information capacity, expanses. Commercial, private, and public interests rush in to colonize newly opened territories. Boundaries are drawn. Areas of exclusion are created, even in our most intimate spaces: bedsides, living rooms, kitchens, the heart and the mind: a diabetic is not able to modify her insulin pump software; the smart television contains proprietary firmware, controlled at a distance and without explicit consent. The struggle is not one for virtual, but actual grounds for inscription.

These intimate territories are however remote, in that they unfold at quantum scale. Individuals not privy to the mechanics of micromolecular writing are hence in peril of unprecedented dispossession. I am concerned here with our basic ability to shape discourse—to read and write—along surfaces that are not available for immediate scrutiny. Poetics—the affordance of literary space—physically limits the possibility of interpretation. A sign illegible is one that never enters the hermeneutic circuit.

In making the case for a computational poetics, I am helped by recent scholarship in the historically- and philosophically-inflected studies of media and technology.[[13]](#endnote-14) My notion of poetics builds also on the long history of literary theory, in the genealogy of formalist and structuralist schools. My approach is not however limited to the canonical, straight-ahead structuralisms of Roman Jakobson or Jonathan Culler. I am borrowing rather from a more peripheral tradition represented best by third culture thinkers like Viktor Shklovsky and Vilém Flusser, consummate immigrants both, who extracted a methodology out of the fabric of their displacement.

Flusser in particular considered the condition of unease that comes with migration, both physical and mental, to be a kind of information processing. His thought was influential in making sense of my own displacements, first as a refugee fleeing the dissolution of the former Soviet Union, then a transplant into Silicon Valley from a strict literary education, and now a lapsed engineer among humanists. These vantage points offer a singular view onto the material conditions of contemporary intellectual life.

Both Shklovsky and Flusser wrote lucidly about the dynamics of settlement. Their work sheds light onto an irresistible compromise, at the core of all technology, by which we trade critical understanding for comfort. Habit covers the various homes we make for ourselves in the world “like a fluffy blanket,” Flusser wrote: “[i]t smoothes the sharp edges of all phenomena that it covers, so that I no longer bump against them, but I am able to make use of them blindly.” When we sit at our desks, for example, we fail to see “papers and books that are lying all about.” We are used to them being there as they are.[[14]](#endnote-15) We do not thereafter parse them as information. Like water that surrounds fish, habituated things pass into the background of experience. Mediums become media. They cease producing meaning, become stages for meaning-making, and like a stage disappear from view.

Losing sight of the material contexts of knowledge production is politically perilous, because those who own the contexts set the terms of engagement. Estrangement arrests material concealment. Exile allows the displaced to once again transform habituated media into meaningful information. In exile, “everything is unusual,” Flusser wrote.[[15]](#endnote-16) Migrants experience the world as ex-perience [*er-fahrung*], or literally a driving out. Discovery, he concluded “begins as soon as the blanket is pulled away,” where familiar objects can pass into view again.[[16]](#endnote-17)

One could write, to take a simple example, “a field of study,” without much thought about figurative space. Shklovsky would have readers pause to consider the implications.[[17]](#endnote-18) In what sense do ideas resemble (or not) a field? The poet could take things further and elaborate: “to scythe a verdant field of literary study.” The verb (to scythe) and the adjective (verdant) create an unexpected transference of new qualities not present in the original image (intellectual field). These qualities “overdetermine” or “saturate” the metaphor, exposing its conceit. One can do to fields of grass what one cannot to ideas. Subsequently, we realize that the two domains—intellectual and horticultural—do not map onto each other perfectly, leaving a semantic remainder: the chaff. Readers discover intellectual “fields” for what they are: habituated metaphors, neither natural nor self-apparent. Metaphors are made strange again through purposeful defamiliarization. To take the technique to its logical conclusion, a writer could depict several fictional characters in the act of scything a field of grass while discussing the relative merits of structuralism: a discussion about the field on a field. Such literary artifice would make actual the implied connections between fields of grass and ideas. The writer now shows what was merely told before. The technique of defamiliarization finally renews the figure: discarding hardened clichés while suggesting novel linkages between constituent concepts: ideational chaff, leaves of mental grass, combines of thought.

I would like to affect a similar sense of estrangement when it comes to our use of technology. The formalists understood habituated metaphors to diminish the vitality of experience. Shklovsky quotes from the diaries of Lev Tolstoy, who, while dusting his room, could not remember if he had already dusted his sofa. Tolstoy wrote:

because actions like these are habituated and unconscious, I could not remember […] whether I dusted and forgot or just did so without thinking—it was as if the action never happened […] thus when life passes without conscious reflection, it passes as if one has not lived at all.

Shklovsky added that life so habituated disappears into nothingness, when the automatization of experience “consumes things, clothing, furniture, your spouse, and the fear of war.”[[18]](#endnote-19)

The formalists rarely quoted Marx directly. Yet Marx resonated throughout. For Marx, dead metaphors marked alienation from humanity.[[19]](#endnote-20) The point at which material artifacts disappear from conciousness is also one where they appear within the social sphere as fetishes.

Shklovksy changed Marx’s German alienation [*Entfremdung*], which for Marx always denied life, into the Russian estrangement [*ostranenie*], literally an “othering,” of the kind that affirms it. The difference is one of agency. In the first case, subjects are treated like objects by others. In the second, they recognize and reject the objectified other within. Formalist estrangement—sometimes also translated as defamiliarization—arrests the momentum of tacitly received habit. Once estranged and extracted like a splinter, ossified experience can be revitalized.

Our challenge today is to uproot ourselves from the comforts that rapidly descend on the dwellings of our intellectual life. Dulling the senses, seemingly inconspicuous conduits of agency—electronic books and smart desks—acquire a sense of intelligence of their own. Devices that “watch,” “hear,” “see,” and “think” give rise to object-oriented ontology and the internet of things. A new generation of objects clamours for participatory intelligence. They claim space in the home, near bed and hearth. Smart phones, smart light bulbs, smart thermostats, smart homes, and smart watches, enter the networked public sphere in the role of independent agents.[[20]](#endnote-21) A conversation begins about their personhood: their levels of trust, friendships, rights, and accountability.[[21]](#endnote-22) Marx’s table that “evolves out of its wooden brain grotesque ideas” now becomes Surface and PixelSense—product names of actual smart tables, available for purchase.[[22]](#endnote-23)

If we hope to understand digital culture and especially literature, as Friedrich Kittler would write, “under conditions of high technology,” we can only do so from the position of humanism. One cannot otherwise lament the systematic erasure of the human from the literary process and, at the same time, advocate for a post- or anti-humanism. Unlike Kittler, who wrote that under conditions of high technology “literature has nothing more to say,” I believe that literature and literary analysis continue to have a voice in contemporary life.[[23]](#endnote-24) Technology does not—cannot be allowed to—determine literary silence. Rather, as the material grounds for all reflective textual activity recede from view, readers face the prospect of selective illiteracy.[[24]](#endnote-25) The command of technologies like networking and encryption separates those able to read and write under conditions of high technology from those who no longer are: another dispossession.

When we mistake things for animate actors, we ourselves become enmeshed in a system of digital production that commodifies human experience. Objects that surround us collect our reading habits, social interactions, and intimate conversations. Agents that benefit from trade in personal data are neither cyborgs nor post-human assemblages. The bargain that trades critical understanding for comfort benefits specific, individual interests. To address objects as if they could respond in kind shifts our attention from seats of power to things powerless, inarticulate, and indifferent to our protestations. One can no more extract justice from a smart desk than hold a bureaucracy accountable. Notions of justice and accountability presuppose a robust model of agency, absent in the assemblage.

The internal exile that we must undergo for smart books and smart desks to come into view cannot compare in difficulty to the experience of physical displacement that follows natural disaster, war, poverty, or political instability. Yet, our systematic reluctance to take on even those small intellectual discomforts that could lead to acts of localized dissent and disobedience—to write using free software, build open archives, or share memories in private—cannot be said to exist outside complex systems that perpetuate inequity and violence globally. The emotional affirmation that accompanies exuberant technesis—the ecstasy of constant communication, for example—brings with it governing structures evoked in the name of law enforcement and national security. Comfort and security constitute the same ill-conceived bargain that leads to critical disempowerment. But where it is difficult to imagine or to enact strategies of digital disobedience on a universal scale, we can begin to address them through numerous minute transactions that in aggregate brace everyday literary exchange. This we can do now. Computational poetics begins with machines in our immediate proximity, closest to thought and touch.

To pick up an electronic book and to take it apart may be against the law in some jurisdictions.[[25]](#endnote-26) Given the extent to which emergent thought-things—epistemic artifacts like electronic books and smart phones—participate actively in the production of meaning, we can no longer employ strategies of interpretation at the level of ideology or representation alone.[[26]](#endnote-27) The praxis of close reading must reach down to the silicon bedrock: material entities and physical structures that bear the weight of interpretation. Literary theory, a discipline fundamentally engaged in the exegesis of figurative trope, is therefore crucial to the understanding of new computational environments, which have enveloped intellectual life through metaphoric substitution. To read the machine is to learn how it is made, but also to unpack the rich metaphors that guide our tactical engagement with the word: the boot in rebooting, the wares in software, the bug and the joystick, the interpreter and the shell.

### *Settlement*

Estrangement cannot however be practiced effectively in monologue. To produce meaning, Flusser reminds us, it needs to become a dialogical, dialectical practice. Perpetual exile is otherwise uninhabitable.[[27]](#endnote-28) Without the shelter of one’s home, everything turns to noise. Information cannot exist without dwelling, Flusser wrote, “and without information, in a chaotic world, one can neither feel nor think nor act.”[[28]](#endnote-29) Estrangement thrusts the displaced into the chaos of unsettled existence. With time, they make a new home, from which they can once again “receive noise as information” and produce meaning. “I am embedded in the familiar,” Flusser wrote, “so that I can reach out toward the unfamiliar and create things yet unknown.”[[29]](#endnote-30) A dialectics of exile leads to “informed renewal” of shared space, through what Flusser called a “creative dialogue” between the settled and the displaced.[[30]](#endnote-31)

In *Plain Text*, I thus model the reciprocal movement to “making strange” on the diverse practices of reverse engineering. Similar in method to what Matthew Kirschenbaum called “forensic argumentation,” reverse engineering recalls the formalist strategy of structural decomposition.[[31]](#endnote-32) The function of case studies in an engineer’s education, as Henry Petroski explained in his *Invention by Design*, is to understand the ways by which one gets “from thought to thing.”[[32]](#endnote-33) From thought to thing would be another apt definition of poetics and an alternate subtitle to this book. Along with literary and historical exposition, each of my chapters contains at least one literary thought-thing. Each enacts a deconstruction—a literal taking apart—of that device. The epistemic object is meant to challenge received theoretical intuition.

Reverse engineering of literary devices reveals that not all texts are created equal. In print, traditional distinctions between form and content lie flat. The printing press embeds ink into paper, leaving no space between type and page. Materially-minded critics like Johanna Drucker, Katherine Hayles, and Jerome McGann have urged literary scholars to re-evaluate textuality in its media-specific contexts.[[33]](#endnote-34) Their work reminds us that the flatness of digital text is an illusion. Low-level operational intuitions governing textuality—ideas about form, content, style, letter, and word—change profoundly as text shifts its confines from paper to pixel.

A substantial gap separates visible text from its storage medium. The two sites of inscription—screen and electromagnetic storage—are physically incongruent. One must be translated, transformed into the other. Control codes govern the process of trans-figuration, which brings with it physical control at the level of platform and architecture. This is a layer where, for example, we can find spyware and censorship filters, digital rights management and advertisement delivery.

I propose we begin then with this obvious sense of difference between paper and pixel: where print is governed by law from without, think for example of England’s Obscene Publication Acts, digital text is governed by code, from within.[[34]](#endnote-35) I will go further than others to maintain that digital text *is* code, in the sense that it is always parsed and potentially executable.[[35]](#endnote-36) Control binds to content inextricably, to become an organ in the same unified corpus.

Changing material conditions of textual transmission push against familiar ideas of literary criticism. For example, the easy reproduction of digital text weakens the material basis for authorship attribution. Text that is easy to copy is easy to cite and plagiarize. The weakening of the authorship function makes certain ways of talking about ideas like “authorial intent” and “fidelity to the original” difficult to sustain. The emergence of massive, community-based writing initiatives like Wikipedia along with algorithms that write spam or summarize news automatically, further erode notions of authorship based on individual genius.

Author do not die, however; they continue to live and collect royalties.[[36]](#endnote-37) Autopoiesis—literature writing or discourse speaking itself—does not displace the social institution of authorship.[[37]](#endnote-38) Codification merely makes the flows of poiesis less apparent. It is difficult, but not impossible, for example, to find the programmer responsible for sending spam or credit writers based on Wikipedia contribution history. Spammers are sentenced just as notable Wikipedia contributors receive barn stars in recognition of their efforts.

Extant models of literary transmission assume movement through passive and immutable media. Paper constitutes the document of record, which, once archived, does not change its contents. Philological techniques like genetic criticism and forensic reading make it possible to reconstruct if not “authorial intent,” then at least a trace of an author’s hand. In some cases—think manuscripts and folios—we may even ascribe properties like “fidelity” to “original” works of art. When media are immutable, one imagines a causal chain of custody between works and their creators, who at some point must have occupied the same contiguous time and space: the closer a parchment to Shakespeare, the higher its evidentiary (and market) value.

The transition between Gutenberg press and Project Gutenberg, an online library containing thousands of texts, complicates the linkage. Unlike pen and paper, which come in direct contact with each other during writing, the bridge between keyboard and screen passes through multiple mediating filters. Writing itself becomes a programmed experience. We do not write in the conventional sense of etching marks into a static host, “at the same time and space.” The act is a simulation displaced. We neither immediately touch nor see the textual conduit. The visible does not correspond to the actual. Simulated erasure for example, of the kind that happens when a writer presses the backspace key, does not necessarily entail the corresponding erasure of content on disk. The “erased” word could persist and even multiply across other storage drives and devices. Erasure itself becomes a meaningful data point, used to train algorithms or in evidence of intent to conceal. The sign’s fracture entails such palpable consequences.

Poetics reconstructs a sequence of willful delegation: from thought—someone’s thought—to thing. A discipline of close attention to the minute particulars of encoding, transmission, storage, and the decoding of texts reclaims a measure of intent and thereby authorial responsibility. In many cases, we may not care to speak of it. One would hardly find Tolstoy “at fault” for his *War and Peace*, for example. In other contexts, as when unsolicited advertisement clutters bandwidth to the exclusion of other forms of speech, we must. This may seem strange at first: to recover the subject in the physical minutiae of the encounter between text and machine. The point of contact between human, text, and device is significant because it is here, in the liminal zone of semiotic exchange, where subjects disappear into machines and where machines step forth as animated and seemingly intelligent actors. Our ability to apprehend the politics of smart objects therefore depends on the formulation of their poetics: how they are made.

## Method

We cannot separate the two things: head and hand […] the science of life […] is a superb and dazzlingly lighted hall which may be reached only by passing through a long and ghastly kitchen […] [W]e shall reach really fruitful and luminous generalizations about vital phenomena only in so far as we ourselves experiment and, in hospitals, amphitheaters, or laboratories, stir the fetid or throbbing ground of life.[[38]](#endnote-39)

My approach to writing *Plain Text* stems from the desire to enact theory capable of addressing the grim picture Friedrich Kittler painted at the end of his influential monograph.[[39]](#endnote-40) By all accounts, Kittler was neither a technological romantic nor Luddite. I hence understand his *Gramophone, Film, Typewriter* as a call to action. When Kittler wrote that “media determine our situation,” he challenged his reader to choose between complicity and defiance.[[40]](#endnote-41) It was not a statement of fact but the articulation of a question: What can one do to counteract technological determinism? In what follows, I outline several intellectual lineages—materialist, pragmatist, and experimental—which frame my answer.

Critical theory at its best aims to see “the human bottom of nonhuman things.”[[41]](#endnote-42) As such, it is one of our most powerful tools for analysis and resistance against technological determinism. Max Horkheimer wrote that the issue “is not simply the theory of emancipation; it is the practice of it as well.”[[42]](#endnote-43) Recently, scholars like Kathleen Fitzpatrick, Tiziana Terranova, and Trebor Scholz have began to turn the tools of critical theory towards the instrumental contexts of knowledge production.[[43]](#endnote-44) I join them to argue that in treating the instruments of intellectual production and consumption uncritically, all of us—readers and writers—accumulate an ethical debt. It is one thing to theorize about the free movement of literary tropes across cultures and continents, and quite another to have that theory appear in print behind paywalls inaccessible to most global reading publics.[[44]](#endnote-45) Similarly, a theoretical distinction between form and content, when instantiated in specific file formats like Microsoft Word (.docx) or Adobe Reader (.pdf), establishes divisions of labor between editors, book sellers, and offshore typesetting firms.[[45]](#endnote-46) One group trades content in the economy of prestige, another formatting in the economy of survival, yet another controls distribution in economy of the market.

Distinctions of labor will persevere as long as theory persists in the abstract. A materialist critique cannot achieve its stated aims without purchase on the material world. Contemporary knowledge workers stare into rectangular black boxes for a considerable part of their days, suspecting, in the absence of other feedback, that their gaze is met in bad faith. Bad faith points to a misalignment between thought and action.[[46]](#endnote-47)

Connecting theories of meaning-making to their practice offers a way out of the conundrum. The solution to connect “meaning” with “operational meaning” thus belongs equally to a species of pragmatism, as it does to critical theory. William James articulated the approach concisely when he wrote that “reality is seen to be grounded in a perfect jungle of concrete expediencies.”[[47]](#endnote-48) For James and other pragmatists, truth could not be found outside of that jungle, in the abstract. It always entailed real consequences, causes, and effects.[[48]](#endnote-49) In his essay “Pragmatism’s Conception of Truth,” James asked: “How will the truth be realized? […] [W]hat concrete difference will its being true make in anyone’s actual life? […] What experiences will be different from those which would obtain if the belief were false?”[[49]](#endnote-50) Frank Ramsey, the young British philosopher close to Ludwig Wittgenstein, would later write in a similar vein about meaning “defined by reference to the actions.”[[50]](#endnote-51)

For a pragmatist, truth-carrying propositions of the shape “X is Y” (as in, “the author is dead” or “art is transcendent”) beg the questions of “Where?,” “When?,” “For whom?,” and “What’s at stake in maintaining that?” Following the pragmatic insight of James and Ramsey, I will proceed with the conviction that abstract categories like “literature,” “computation,” and “text” cannot possibly be reduced to a number of essential, structural features. Rather, to borrow from Wittgenstein’s *Philosophic Investigations*, categories denote a set of related practices that share in some familial characteristics.[[51]](#endnote-52) In our case, imagine a tree diagram where the branches of computation and textuality intersect and diverge in ways that we have yet to untangle.

In an approach to *doing* theory, *Plain Text* joins the experimental turn steering the academy toward critical practice, especially in fields long-dominated by purely speculative thought. The experimental turn represents a generation’s dissatisfaction with armchair philosophizing. Recall the burning armchair, the symbol of the experimental philosophy movement. Joshua Knobe and Shaun Nichols, some of the early proponents of the movement, explain that “many of the deepest questions of philosophy can only be properly addressed by immersing oneself in the messy, contingent, highly variable truths about how human beings really are.”[[52]](#endnote-53) The emergence of spaces where research in the humanities is done exemplifies the same trend. In naming the locations of their practice “laboratories,” “studios,” and “workshops,” humanists reach for new metaphors of labor. These metaphors aim to reorganize the relationship between body, space, artifact, knowledge, and inscription. In my lab and elsewhere, researchers have taken to calling this approach “experimental humanities.”

As an example of what I have been calling here the “experimental turn” in the field of early modern history consider the preface to a recent volume on *Ways of Making and Knowing*, edited by Pamela Smith, Amy Meyers, and Harold Cook. They write that the “history of science is not a history of concepts, or at least not that alone, but a history of the making and using of objects to understand the world.”[[53]](#endnote-54) Smith translates that insight in the laboratory, where, together with her students, she bakes bread and smelts iron to recreate long-lost artisanal techniques. For those who experiment, “book knowledge” and “artifactual knowledge” connect in practice.

Artifactual knowledge—from typesetting software to e-book readers and word processors—shapes our everyday encounter with literature. Such technologies should not be understood as value-neutral conduits of information. I follow Lewis Mumford and Langdon Winner to argue that technology affects the exercise of textual politics in subtle and profound ways.[[54]](#endnote-55) Artifacts cannot hold beliefs about politics. Political power is rather exercised through them. For example, stairs do not discriminate against the mobility impaired. The human failure to enforce accessibility through specific legal and architectural choices does. Typesetting software, e-book readers, and word processors similarly embody implicit communication models: ideas about deliberation, ethics of labor, discursive values, and views about “natural” human aptitude for interpretation. The maker of the electronic book encodes how the book is sold and where, minimum and maximum font size, the visibility of marginal notation, the possibility of sharing, the availability of the critical apparatus. Content in that sense is meant for further processing, in a way that maximizes its extracted value. Contemporary documents are capable of structuring the literary encounter to these ends according to the reader’s economic status, gender, race, age, location, or physical ability.

To what extent does the book in front of you permit or enable access? Whatever the answer, a function of understanding the text includes the explication of its physical affordances. An experimental approach to reading enables the critic to “lay bare” the device. A literary scholar’s version of baking bread and smelting iron is to make literal the archaeology of media at the level of the mechanism. In *Plain Text* we will unearth and excavate textual machines. In practicing archaeology I contend that cardinal literary-theoretical concepts—such as word, text, narrative, discourse, author, story, book, archive—are thoroughly enmeshed in the underlying physical substratum of paper and pixel. It follows that any attempt to articulate the idea cannot attain its full expressive potential without a thick description of its base particulates.

Luckily for us, reading and writing are not esoteric activities. They are readily available to introspection. I will therefore occasionally encourage readers to encounter the immediate contexts of their reading anew: to put down the book or to lean away from a screen and to look at these textual artifacts with strange eyes. In this movement of the body, I want to disrupt the mind’s habituated intuitions, pitting them against knowledge at hand and fingertip knowledge: as when ruffling through the pages or typing at a keyboard. How ephemeral is an electronic text, for example? The pragmatic answer lies not in reductive universal propositions—very, or not at all—but in contingent technological affordances attached to specific reading devices. What can a reader do with this text, here and now? Where is it stored? Are readers given dispensation to copy and paste? Do they have legal permission to quote at length, to perform publicly, or to otherwise trans-mediate? Will the text disappear when the reader closes the book’s cover?

## Plan of the Present Work

The tangled pathways of inscription winding their way through the device exist in relation to distinct communities of computational practice. A researcher cannot for this reason expect to discover a single theoretical framework that captures the complexity of digital text in motion. An engineer’s use of the words “code” and “poetry” differs from that of a poet’s. The changing contexts evoke a corresponding shift in operational definitions. This book is thus neither a total history of modern computing nor a survey of literary theory. Rather, the argument therein progresses from the action of the alphanumerical keyboard switch, through copper and silicon, to liquid crystal and the floating gate, and on towards the reader and the community. It is but one of many possible passes through a cavernous black box.

At the core of the book’s **first chapter** lies the notion of a modernist literary device, understood both as literary technique and thought experiment about intelligent machines, directly connected to the birth of modern computing. A section on literary technique in the work of Percy Lubbock, Walter Benjamin, and Mikhail Bakhtin opens the discussion. Materialist poetics rise concomitantly alongside a mechanistic, rule-based view of language. In this chapter I reconstruct a series of thought experiments first in the writing of Ludwig Wittgenstein and then in Alan Turing’s seminal paper on an imaginary computer capable of reading and writing. The verbs to read and to write imply a type of cognitive processing. What does it mean to read and to write for a machine? What about broken mechanisms of comprehension? At once a device and an algorithm, the Turing machine blurs the boundaries between software and hardware, code and content, intelligence and its imitation.

The *second chapter* begins with a question. What does it mean to turn a page, I ask, when neither pages nor the action of turning them correspond to the implied analogy? A close reading of the metaphor leads to an intellectual history of human-computer interaction. It progresses from “conversational programming” to “direct manipulation” schools, the latter shaped by theories from cognitive linguistics and immersive theater. The logic of “directness” culminates in the rapidly developing field of brain–computer interfaces. The chapter concludes with a moment of speculative formalism, in which I consider the possibility of affective literature, of the kind that eschews language and representation.

Two rich intellectual histories collide in the **third chapter**: form in literary theory and format in computer science. I show formatting as a process that mediates between a text’s intrinsic rules for construction and its extrinsic shape, transforming one type of structure, a series of bits arranged into tracks and sectors, into another, letters arranged into sentences and paragraphs. I then draw a short history of text formats. It begins with several “control characters” limited in function to actions like “carriage return” or “stop transmission.” With time, formats begin to encompass all manner of machine instruction, including legal instrument to enforce digital rights management and copy protection. A manufacturer’s ability to censor or to surveil digital text is contained within the formatting layer: from electronic books that modify themselves to suit the reader’s geographic location to “smart contracts” that contain the rules of their own execution.

The **fourth chapter** charts the emergence of screen reading. Screens restore a measure of visibility lost to electromagnetic inscription, with one major side-effect. Fidelity between visible and archived inscription cannot be guaranteed. Screen reading further happens on screens that refresh themselves at a rate of around 60 cycles per second (Hertz). The digital word is technically an animation; it moves even as it appears to stand still. This property attunes the reader to a particular mode of apprehension, affecting not just the physics but also the aesthetics of digital media. Works by philosophers Henri Bergson, John Haugeland, and Nelson Goodman construe a phenomenology of screen-based digital perception. The digital emerges not as a medium’s intrinsic property, but structure imposed from without. In the extreme, that means that a censored *electronic* text can form a perfectly *analog* artifact, despite being digital in all other senses of the word. Conversely, texts in print are already “born digital,” in the sense that literary works like Shakespeare’s *Hamlet* are amenable to “reliable processes of copying and preservation.”[[55]](#endnote-56) Properties that make media “digital” or “analog” reveal themselves to be neither universal nor essential to the medium. The medium is not the message. “Reliability and preservation of textual copies” may mean one thing to a literary scholar, another to a software engineer or a legal professional, and something entirely different to a librarian, I argue in the conclusion of the chapter. It matters not what the text is, but what we can do with it.

The **fifth and final chapter** begins with a discussion of an apparent paradox. A camp of media theorists and textual scholars in the 1990s conceived of electronic texts as an ephemeral, almost immaterial, phenomenon. Text shimmered and glared: it was spoken of in terms of hypertext, light writing, and electricity. A generation of theorists that came after insisted on the weighty materiality of electronic media. Reading began to engage the morphology of rare metals, media archaeology, hard drive forensics. Both accounts, I argue, capture an aspect of the same underlying condition. The perceived image of an archived inscription splits from its source. The sign plausibly resides both on screen and hard drive. It fractures, in some real sense, diverging at the site its projection from the site of the archive. Using materials from the history of telegraphy in the late nineteenth and early twentieth centuries, I chart the gradual fissure and ultimate illegibility of the newly composite sign. Marks made on punch cards and ticker tape protruded through the medium. Although difficult to read, these forms of machine writing were readily visible and therefore amenable to analysis. The advent of magnetic storage forced the composite inscription into an opaque conduit. Unable to perceive magnetic polarities without the aid of a machine, readers often manipulated text blindly. In this way a typist would type several sentences without seeing the printed output. The chapter identifies a milestone in the history of human textuality: the moment at which the inscription passed from view, giving rise to the sometimes conflicting but nevertheless consistent accounts of digital textuality.

A short **conclusion** gestures towards the contemporary political consequences of the material covered, discussing also the possibility of machine phenomenology in relationship to humanism. Computational poetics, I maintain, encourages users to become active thinkers, tinkerers, and makers of technology. It understands digital environments to be also systems of semiotic exchange, amenable to the construction and the deconstruction of meaning. I further encourage those who may have considered themselves mere “users” of computation to apply the same critical acuity they employ in the close reading of prose and poetry to the understanding of code and machine. For text to render on screen properly it must be encoded or translated from machine-transmittable code into human-readable shape. Encoding constitutes a primitive field of textual activity, at the crossroads of computer science and the study of literature. Encoding matters because how texts are encoded, transmitted, and stored decides who gets to decode, receive, and revise.

1. See Bök, “The Xenotext Works.” and Bök, *The Xenotext*: “I have been striving to write a short verse about language and genetics, whereupon I use a ‘chemical alphabet’ to translate this poem into a sequence of DNA for subsequent implantation into the genome of a bacterium (in this case, a microbe called *Deinococcus radiodurans*—an extremophile, capable of surviving, without mutation, in even the most hostile milieus, including the vacuum of outer space).” [↑](#endnote-ref-2)
2. Unicode Consortium, “The Unicode Standard,” 9–10. [↑](#endnote-ref-3)
3. Cook, “Some Considerations in the Concept of Pre-Copy-Text.” [↑](#endnote-ref-4)
4. See Ku, “Critique of the Digital Millenium Copyright Act’s Exception on Encryption Research.”; Ginsburg, “Legal Protection of Technological Measures Protecting Works of Authorship.”; and Fry, “Circumventing Access Controls Under the Digital Millennium Copyright Act.”. [↑](#endnote-ref-5)
5. The retailer has since introduced a program that allows for limited sharing of materials, restricted by time and geography. [↑](#endnote-ref-6)
6. Winner, *Autonomous Technology*, 335. [↑](#endnote-ref-7)
7. Scholars like Alexander Galloway, David Golumbia, Bernard Harcourt have advanced critique along similar lines. See Galloway, *Protocol*, Golumbia, *The Cultural Logic of Computation*, and Harcourt, *Exposed*. [↑](#endnote-ref-8)
8. Halstead, “The Genesis and Speed of the Telegraph Codes,” 456. [↑](#endnote-ref-9)
9. I borrow the term “microanalysis” from the largely forgotten in the West Russian literary scholar and member of the Moscow Linguistic Circle, Boris Iarkho. In his *Methodologies of Exact Literary Study* (circa 1935-6) he wrote, in my translation: “I understand ‘atomism’ as a sort of an ideal aspiration, an orientation toward the liminally small. But under no circumstances do I advocate working with hypothetical quantities, like molecules, atoms, positrons, and so on, which are located beyond the limits of perception. That this applied mythology gave us such splendid results in chemistry, should not conceal its true nature. Tomorrow, all such explanations of visible through the invisible could give way to other hypotheses, as was the case with their no less fertile predecessors (elemental spirits, phlogiston, and light ether). But the cell, the nucleus, and the chromosome endure as lasting accomplishments of microanalysis. I suggest to move as far as a microscope can reach, and no further” Iarkho, *Metodologia Tochnogo Literaturovedenia (Methodologies of Exact Literary Study)*, 363–64. [↑](#endnote-ref-10)
10. Affordances, as Caroline Levine explains, “describe the potential uses or actions latent in materials and designs.” For example, “[g]lass affords transparency” where “[s]teel affords strength” Levine, *Forms*, 6. See also Hutchby, “Technologies, Texts and Affordances.”, 447. [↑](#endnote-ref-11)
11. Leroi-Gourhan, *Gesture and Speech*, 83–84; Siegert, *Cultural Techniques*. [↑](#endnote-ref-12)
12. I am influenced in this regard by the philosophical poetics of Gaston Bachelard and Henri Lefebvre, extended into the realm of everyday computation. See Lefebvre, *The Production of Space*; Bachelard and Stilgoe, *The Poetics of Space*. [↑](#endnote-ref-13)
13. Works by Finn Brunton, Wendy Chun, Lisa Gitelman, Yuk Hui, Helen Nissenbaum, John Durham Peters, Mary Poovey, and Jonathan Sterne among many others left their mark on this text. [↑](#endnote-ref-14)
14. Flusser, *The Freedom of the Migrant*, 13; Finger, Guldin, and Bernardo, *Vilém Flusser*, 132. [↑](#endnote-ref-15)
15. Flusser, *The Freedom of the Migrant*, 81. [↑](#endnote-ref-16)
16. Ibid., 82–83. [↑](#endnote-ref-17)
17. Shklovksy et al., *Sborniki (Po Teorii Poeticheskogo Iazyka)*. [↑](#endnote-ref-18)
18. Shklovksy et al., *Poetika*, 104. Translations are mine unless source cited explicitly in English. [↑](#endnote-ref-19)
19. For more on alienation see the relevant discussion in Marx, *Economic and Philosophic Manuscripts of 1844* and Marx, *Theories of Surplus-Value*. [↑](#endnote-ref-20)
20. See for example: “[w]riters concerned with with problems of technology-out-of-control have frequently echoed Hobbes in suggesting that such an artifact—the Leviathan of interconnected technical systems—has a soul of its own […] A ghost appears in the network. Unanticipated aspects of technological structure endow the creation with an unanticipated *telos*” Winner, *Autonomous Technology*, 280. [↑](#endnote-ref-21)
21. Bohn et al., “Living in a World of Smart Everyday Objects—Social, Economic, and Ethical Implications”; Jianhua Ma et al., “Towards a Smart World and Ubiquitous Intelligence”; Calverley, “Android Science and Animal Rights, Does an Analogy Exist?”; Hildebrandt, “Ambient Intelligence, Criminal Liability and Democracy”; Atzori, Iera, and Morabito, “From ‘Smart Objects’ to ‘Social Objects’.” [↑](#endnote-ref-22)
22. Marx, *Capital*, 82; Wigdor, Fletcher, and Morrison, “Designing User Interfaces for Multi-Touch and Gesture Devices.” [↑](#endnote-ref-23)
23. Kittler, *Gramophone, Film, Typewriter*, 263. [↑](#endnote-ref-24)
24. See for example Postman, *Technopoly*; Negroponte, *Being Digital*; Davidson, *Now You See It*; Obama, United States, and White House Office, *The 2016 State of the Union Address*. [↑](#endnote-ref-25)
25. Fry, “Circumventing Access Controls Under the Digital Millennium Copyright Act.” [↑](#endnote-ref-26)
26. I am in influenced here by the discussion of epistemic things in Rheinberger, *Toward a History of Epistemic Things*, 24-37. [↑](#endnote-ref-27)
27. Flusser, *The Freedom of the Migrant*, 81. [↑](#endnote-ref-28)
28. Ibid., 12. [↑](#endnote-ref-29)
29. Ibid., 12. [↑](#endnote-ref-30)
30. Ibid., 84. [↑](#endnote-ref-31)
31. Kirschenbaum, *Mechanisms*, 15. On the role of reverse engineering in media studies see also Fuller and Goffey, *Evil Media*, 9. [↑](#endnote-ref-32)
32. Petroski, *Invention by Design*, 3–7. [↑](#endnote-ref-33)
33. Drucker, “Digital Ontologies”; McGann, *Radiant Textuality*; Hayles, “Print Is Flat, Code Is Deep.” [↑](#endnote-ref-34)
34. On Obscene Publication Acts see McCalman, “Unrespectable Radicalism”; Roberts, “Morals, Art, and the Law.” [↑](#endnote-ref-35)
35. See discussion in Manovich, *The Language of New Media*, 48; Chun, “On Software, or the Persistence of Visual Knowledge,” 27–28; Galloway, “The Anti-Language of New Media.” [↑](#endnote-ref-36)
36. See Barthes, “The Death of the Author.”; Foucault, “What Is an Author?”; Nesbit, “What Was an Author?”. [↑](#endnote-ref-37)
37. See for example Heidegger, *Pathmarks*, 57: “For the phenomenon most worthy of thought and questioning remains the mystery of language—wherein our entire reflection has to gather itself—above all when it dawns on us that language is not a work of human beings: language speaks.” See also Varela, Maturana, and Uribe, “Autopoiesis.”; Barthes, *The Rustle of Language*, 5; Blanchot, *The Work of Fire*, 41 Nuttall, *A New Mimesis*, 6-25. [↑](#endnote-ref-38)
38. Bernard, *An Introduction to the Study of Experimental Medicine*, 3,15. On Bernard see Petit, “Claude Bernard and the History of Science.”; Sattar, “The Aesthetics of Laboratory Inscription.”; and McLuhan, *The Gutenberg Galaxy*, 4 & 206. [↑](#endnote-ref-39)
39. *Gramophone, Film, Typewriter* ends as follows: “And while professors are still reluctantly trading in their typewriters for word processors, the NSA is preparing for the future: from nursery school mathematics, which continues to be fully sufficient for books, to charge-coupled devices, surface-wave filters, digital signal processors including the four basic forms of computation. Trenches, flashes of lightning, stars—storage, transmission, *the laying of cables*.” Kittler, *Gramophone, Film, Typewriter*, 263. [↑](#endnote-ref-40)
40. Ibid., xxxix. [↑](#endnote-ref-41)
41. Horkheimer, *Critical Theory*, 143. [↑](#endnote-ref-42)
42. Ibid., 233. [↑](#endnote-ref-43)
43. Scholz, *Digital Labor*; Fitzpatrick, *Planned Obsolescence*; Terranova, *Network Culture*. [↑](#endnote-ref-44)
44. See also English, *The Economy of Prestige*; Brouillette, “Wither Production?” and Brouillette, “Unesco and the World-Literary System in Crisis.”. [↑](#endnote-ref-45)
45. See Freeman, *High Tech and High Heels in the Global Economy* and Patel, *Working the Night Shift Women in India’s Call Center Industry*. [↑](#endnote-ref-46)
46. Sartre would write “transcendence” and “facticity.” See Sartre, *Being and Nothingness*, 86-119. [↑](#endnote-ref-47)
47. James, “Pragmatism’s Conception of Truth,” 233. [↑](#endnote-ref-48)
48. For a more thorough discussion on the topic see Seigfried, *William James’s Radical Reconstruction of Philosophy*, Pihlström, *Structuring the World*, and Putnam, “James’s Theory of Truth.”. [↑](#endnote-ref-49)
49. James, “Pragmatism’s Conception of Truth,” 200. [↑](#endnote-ref-50)
50. Ramsey, *The Foundations of Mathematics and Other Logical Essays*, 155. [↑](#endnote-ref-51)
51. Wittgenstein and Anscombe, *Philosophical Investigations*, 67-77. For more on the connection between Wittgenstein and James see Goodman, “James on the Nonconceptual.”. [↑](#endnote-ref-52)
52. Knobe and Nichols, *Experimental Philosophy*, 3. [↑](#endnote-ref-53)
53. Smith, Meyers, and Cook, *Ways of Making and Knowing*, 12. [↑](#endnote-ref-54)
54. Mumford, “Authoritarian and Democratic Technics”; Winner, “Do Artifacts Have Politics?” [↑](#endnote-ref-55)
55. Haugeland, “Analog and Analog,” 213–25. [↑](#endnote-ref-56)