

Networks of Deep Impression: Shakespeare and the History of Information

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I. EASY NUMBERS: SHAKESPEARE AND COMPUTING

Thou in our wonder and astonishment
Hast built thy selfe a lasting Monument:
For whil'st to th'shame of slow-endavouring Art
Thy easie numbers flow, and that each part,
Hath from the leaves of thy unvalued Booke,
Those Delphicke Lines with deepe Impression tooke
Then thou our fancy of her selfe bereaving,
Dost make us Marble with too much conceiving,

—John Milton, “An Epitaph on the admirable
Dramaticke Poet, VV. Shakespeare”¹

I WOULD LIKE TO THINK THAT MILTON somehow knew he was writing about computing. Since the advent of digital textuality, Milton's encomium to Shakespeare in the 1632 Second Folio has acquired significance he could not have foreseen. In particular, the word “numbers” gathers together several meanings: numbers as the metrical units of Shakespeare's verse; numbers as musical signs of order in the melodic, harmonic, and rhythmic qualities of Shakespeare's poetry; numbers as objects in a collection that may be enumerated in a totality, in the manner that John Heminge and Henry Condell (inaccurately) describe the First Folio plays as being “absolute in their numbers”; the numbers of Shakespeare's Sonnets, which we use along with first lines as identifiers; the Old Testament book of Numbers, which deals with a census (the same type of event that led to one of the first preelectronic computers, the Hollerith Tabulator); and numbers as the type of data usually associated with computation at

This work was supported by a grant from the Social Sciences and Humanities Research Council of Canada. I am grateful to Bradley Clissold, M. J. Kidnie, Jennifer Lokash, and Paul Werstine, as well as Katherine Rowe and the peer reviewers, for their comments on drafts of this article. I am also grateful to Emily Monks-Leeson for editorial assistance. Any errors are my own.

¹ *Mr. William Shakespeares Comedies, Histories, & Tragedies* (London, 1632), sig.[A5r].

its most essential—computers have their historical roots in the processing of numbers, not text.² Milton also evokes a form of textual transmission familiar to anyone who uses a personal computer, that of making exact copies in an instant and on practically any scale. As anyone who has suffered major data loss can attest, modern computing forces upon us an equivalence between copying and preservation. Since a digital text's "deep impressions" are merely positively or negatively charged electrons on a magnetized disk surface—or the microscopic impressions laser etched into an optical disk—the devices we now associate with computing provoke a complex set of responses to preservation, largely in the absence of a single trusted substrate for digital archiving. In digital media, preserving data means keeping numbers flowing.

This essay argues that Shakespeare's numbers flow with a difference in modern information culture. His texts have come to stand as both ideal and limit case for the concept of information which, in its modern guise, emerged from a late twentieth-century cultural formation that still dominates much current thinking about computing. Idealized as easily encoded, unproblematically transmissible data, Shakespeare's texts supposedly flow naturally into new digital forms of analysis, so that Shakespearean compatibility with digital media has become a truism. In this future-oriented discussion, however, it is easy to forget that Shakespeare and information practices have a long history together. For example, Peter Stallybrass recently argued that Shakespeare's compositional habits reveal that he may have understood more about database structures than we realize.³ A similar sense of anachronism in the service of historical imagination was the tenor of the forward-looking collection *The Renaissance Computer*.⁴ However, like many otherwise valuable discussions of early modern literature and digital textuality, it looked no further back in the history of electronic computing than the early 1980s, when the consumer-oriented machines now on everyone's desktops turned the popular experience of computing into document management, multimedia, communication, and e-commerce. Yet just as Stallybrass's table of Shakespeare's copy-and-paste composition renders "To be, or not to be" newly strange to our eyes, it is worth seeing computers with different eyes by looking at unexpected parts of their history. Shakespeare's part in that

² For "numbers" as metrical units, see *The Oxford English Dictionary*, 2d ed. (Oxford: Oxford UP, 1989), s.v. "number, n.," 17a; as musical signs of order, 17b, 14a, 14b. *OED Online*, <http://dictionary.oed.com/cgi/entry/00328347> (accessed 19 July 2010). For Heminge and Condell's "absolute in their numbers," see *Mr. William Shakespeares Comedies, Histories, & Tragedies* (London, 1623), sig. A3r.

³ Peter Stallybrass, "Against Thinking," *PMLA* 122 (2007): 1580–87.

⁴ Neil Rhodes and Jonathan Sawday, eds., *The Renaissance Computer: Knowledge Technology in the First Age of Print* (London: Routledge, 2000).

history is complex; his texts both underpin and trouble the twentieth century's normative concepts of transmissibility.⁵

The year 1949 was a crucial one for bibliography, information theory, and what we now call humanities computing. The postwar decades saw a boom in Renaissance editing and bibliography; generally, scholars used this period to theorize and codify editorial and bibliographical practices—the former in W. W. Greg's "Rationale of Copy-Text" (first presented as a lecture in 1949) and the latter in the same year with Fredson Bowers's *Principles of Bibliographical Description*.⁶ Even as textual scholars used Shakespeare to theorize the ways literary texts bear the marks of their material transmission, so were information theorists such as Norbert Wiener, Claude Shannon, and Warren Weaver codifying the discipline now known as information studies. Matthew G. Kirschenbaum sees significance in the publication of Greg's and Bowers's foundational works in the same year as Claude Shannon and Warren Weaver's *Mathematical Theory of Communication*, a book that has proven equally foundational in information studies and related fields.⁷ To these formational events I would add another from 1949: the beginning of Jesuit scholar Roberto Busa's groundbreaking use of computers in his *Index Thomisticus*, a concordance to the works of Thomas Aquinas—the project generally credited with initiating the field now known as humanities computing (or more recently, digital humanities).⁸ In this essay, I explore how the idea of the virtual Shakespeare text took shape within this historical confluence, as bibliography, information theory, and computing converged on the same questions.

Although the term *virtual* has suffered much dilution in the theorizing of digital media and hypertext, N. Katherine Hayles provides a clear and useful definition: "Virtuality is the cultural perception that material objects are interpenetrated by information patterns."⁹ Unlike many critics who invoke the term, she

⁵ The historical connections between literature and code go back much further. See Volker Aschoff, "The Early History of the Binary Code," *IEEE Communications Magazine* 21.1 (1983): 4–10; and F. G. Heath, "Origins of the Binary Code," *Scientific American* 227.2 (1972): 76–83. Thanks to Jonathan Hope for these references.

⁶ Fredson Bowers, *Principles of Bibliographical Description* (Princeton: Princeton UP, 1949).

⁷ Matthew G. Kirschenbaum, "Editing the Interface: Textual Studies and First Generation Electronic Objects," *TEXT* 14 (2002): 15–51, esp. 19–20n12; and *Mechanisms: New Media and the Forensic Imagination* (Cambridge, MA: MIT Press, 2008), 213–18; see also Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication* (Urbana: U of Illinois P, 1949).

⁸ On the significance of Busa's work, see Susan Hockey, "The History of Humanities Computing," in *A Companion to Digital Humanities*, ed. Susan Schreibman, Ray Siemens, and John Unsworth (Oxford: Blackwell, 2004), 3–19, esp. 4. Also available online at <http://digitalhumanities.org/companion> (accessed 17 August 2010).

⁹ N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: U of Chicago P, 1999), 13–14; on the term's semantic slippage, see also Julia Flanders, "The Body Encoded: Questions of Gender and the Electronic Text," in *Elec-*

goes to great lengths to define and situate the idea of virtuality in relation to events such as the Macy Conferences on Cybernetics, held from 1946 to 1953. Even so, her descriptions of virtuality sound remarkably akin to the study of literary texts as the New Bibliographers conceived it; as she puts it, "Seeing the world as an interplay between informational patterns and material objects is a historically specific construction that emerged in the wake of World War II."¹⁰ To substitute "literary texts" for "the world" in this quotation would capture the mindset of the New Bibliography, especially in Greg's prewar definition of bibliography as "the science of the transmission of literary documents" and in the postwar turn to compositor analysis led by Fredson Bowers and Charlton Hinman.¹¹ Just as Milton's poem evokes a particularly Shakespearean pattern of transmissible "easy numbers" flowing through the book and leaving deep impressions in other media, so was the New Bibliography determined to trace that flow of information back to its source.

The New Bibliographers' legacy continued, but was contested, especially in the 1990s, when renewed interest in the materiality of texts coincided with the rise of the Web and what we now call the digital humanities. Some digital humanists, especially in the subfield of text analysis, regarded digital tools as means to purge authorial transmissions of noise, while others more influenced by D. F. McKenzie, Jerome McGann, and Randall McLeod imagined digital editions that could represent nonauthorial interventions as meaningful in their own right.¹² McLeod's portmanteau term "transformission" nicely captures the shift in thinking about the dual virtuality and materiality of texts since Greg (although one can detect in Greg's "Bibliography—An Apologia" a conflicted sympathy with the concerns of present-day textual materialists).¹³ The metaphorical coincidences in Milton's sonnet, however anachronistic, anticipate Shakespeare's twentieth-century role as a reference point for information theory, the epistemology that quietly governs the digital texts and tools that humanists

tronic Text: Investigations in Method and Theory, ed. Kathryn Sutherland (Oxford: Clarendon Press, 1997), 127–43, esp. 127–28.

¹⁰ Hayles, *How We Became Posthuman*, 14.

¹¹ W. W. Greg, "Bibliography—An Apologia [1932]," in *Sir Walter Wilson Greg: A Collection of His Writings*, ed. Joseph Rosenblum (Lanham, MD: Scarecrow Press, 1998), 135–57, esp. 135, 137, 141.

¹² Representative examples may be found among the entries in the *Blackwell Companion to Digital Humanities*. Contrast the assumptions about nonauthorial agents in Hugh Craig's "Stylistic Analysis and Authorship Studies" (273–88) and John Burrows's "Textual Analysis" (322–47) with those in Martha Nell Smith's "Electronic Scholarly Editing" (306–22) and Johanna Drucker and Bethany Nowviskie's "Speculative Computing: Aesthetic Provocations in Humanities Computing" (431–47).

¹³ Random Clod [Randall McLeod], "Information upon Information," *TEXT* 5 (1991): 241–81, esp. 246.

work with today. Shakespeare often represents ideal material for transmission and preservation, possessing complexity and cultural importance in equal measure.

That ideal is an unreachable one for some, and Shakespeare just as often becomes the limit case for imagining what new media can do. W. B. Worthen, for example, objects that “the widespread assumption that Shakespeare’s plays can mean the same thing as texts and as performances . . . is, in a sense, an ‘information theory’ understanding of text-and-performance arising from the iterative character of print: in this view, dramatic writing functions like encoded data, which can be properly (and identically) downloaded with the proper theatrical software.”¹⁴ Specifically, Worthen emphasizes that which escapes mechanical iteration: “To the extent that it clarifies the deep contextuality and contingency of performance meanings, drama seems not readily assimilable to ‘information.’”¹⁵

These are substantive objections, not to be taken lightly, but terms like “information theory” (in scare quotes) and “encoded data” should not be taken for granted either. Worthen’s objection highlights the nuance in Hayles’s definition of virtuality, which she qualifies as a *cultural perception*, not an innate quality or universal condition of information. Cultural perceptions are powerful, and it is essential to understand that information, as a concept, performs a kind of cultural work by means of its metaphorical mobility. As Willard McCarty suggests, “Having it is good. Being without it is bad. But its colourless, odourless, tasteless and elusive ubiquity makes the notion, however successful, exceedingly difficult to grasp critically—which fact should make us very suspicious.”¹⁶ Worthen voices that very suspicion with good reason when he objects to the quasi-scientific “sense that a photo carries the same ‘information’ whether it is displayed on [a] cellphone, laptop screen, in the newspaper, or in a gallery exhibition.”¹⁷ This is a notion that grates against the performance- and history-oriented approaches that have enlivened Shakespeare studies even as digital culture has taken shape. As we head into a new decade of digital Shakespeare projects mobilizing the idea of information in various ways, it is worth taking account of our critical grasp on the idea, as well as the claims it makes on us.

¹⁴ W. B. Worthen, “Performing Shakespeare in Digital Culture,” in *The Cambridge Companion to Shakespeare and Popular Culture*, ed. Robert Shaughnessy (Cambridge: Cambridge UP, 2007), 227–47, esp. 241.

¹⁵ Worthen, 240.

¹⁶ Willard McCarty, *Humanities Computing* (Basingstoke, UK: Palgrave Macmillan, 2005), 110. See also Geoffrey Nunberg, “Farewell to the Information Age,” in *The Future of the Book*, ed. Geoffrey Nunberg (Berkeley: U of California P, 1996), 103–38.

¹⁷ Worthen, 240.

Historicizing information technology and practices can be a healthy antidote to a problem that Shakespearians face as they reckon with new media, which McCarty describes as “the common notion that *the* computer has a single nature we should regard as its essence and emergent evolutionary form, whether this be modelling machine, interactive environment, appliance or whatever.” The crux of the problem, McCarty maintains, is how we respond to “the implication, that having discovered what the single nature of computing is, we must either take it or leave it.”¹⁸ Digital Shakespeare scholars would do well to challenge what we could call *computational essentialism* by investigating the prehistories of Shakespeare and new media. The ongoing history of digital Shakespeare research is of course a vital context for this discussion, and there are worthwhile overviews of new and recent projects, but this essay approaches the topic from a different angle.¹⁹ Discussions of digital projects naturally focus on the present, often taking present forms of computing to be the result of technical forces beyond the scope of humanist inquiry. What I offer instead is a critical prehistory which takes the present state of technology not as a given, but as the result of cultural investments that bestow value in some ways and withhold it in others.

The most consequential of those investments were made earlier than we might think, in the middle decades of the twentieth century. By understanding this crucial episode of computing’s cultural history prior to the more familiar PC revolution, we can find new contexts for questions about Shakespeare and digital technologies of the present and future. How does the notion that Shakespeare’s texts are somehow exceptional in all of literature function in scientific knowledge domains like information science, which value generalization over special cases? How does the perception of Shakespeare’s printed texts as information patterns affect their reception and cultural meaning? The following sections take up these questions and trace the cultural imperative to penetrate the veil of code (to paraphrase Bowers) that came to enshroud Shakespeare in the later twentieth century.²⁰ After examining historical and cultural antecedents to the idea of Shakespeare as encoded information, I will explore some of the foundational ideas of information theory and their relation to bibliography, turning

¹⁸ McCarty, 10; see also Michael S. Mahoney, “The Histories of Computing(s),” *Interdisciplinary Science Reviews* 30 (2005): 119–35.

¹⁹ See Andrew Murphy’s review in this issue; and Ian Lancashire, “The State of Computing in Shakespeare,” *Shakespearean International Yearbook* 2 (2002): 89–110; “Monitoring Electronic Shakespeares,” ed. Michael Best, *Early Modern Literary Studies* 9.3, special issue 12 (2004), <http://extra.shu.ac.uk/emls/09-3/09-3toc.htm>; “Reinventing Digital Shakespeare,” special issue, ed. Alan Galey and Ray Siemens, *Shakespeare* 4.3 (2008); and Christie Carson, “The Evolution of Online Editing: Where Will It End?” *Shakespeare Survey* 59 (2006): 168–81.

²⁰ Fredson Bowers, *On Editing Shakespeare and the Elizabethan Dramatists* (Philadelphia: University of Pennsylvania Library, 1955), 87.

finally to the consequences this history holds for digital Shakespeare studies in the present.

II. WARLIKE NOISE: CODE, MACHINES, AND THE WEAPONIZING OF LITERATURE

Professors back from secret missions
 Resume their proper eruditions,
 Though some regret it.
 —W. H. Auden, “Under Which Lyre” (1946)²¹

The transmission narrative most relevant to Shakespeare’s emergence as information holds his texts to be conduits of meaning in the face of catastrophic conflict. Throughout World War II, military communication and intelligence practices invested in a conduit metaphor for information in ways that suited strategic planning and tactical responsiveness.²² Information pioneers like Norbert Wiener and Vannevar Bush played major roles in the mobilization of science during the war, and the interdisciplinary field of cybernetics developed directly out of research on the interface between humans and machines in anti-aircraft targeting systems.²³ Even microfilm had a vital application in military logistics as the technology of mobile libraries that could stand in for the masses of paper documents required in wartime correspondence. Vernon D. Tate’s description of this technology’s military value, in a 1942 article in the *Journal of Documentary Reproduction*, equates it with a weapon because it could free up space on a cargo plane for troops and supplies, as well as provide an encyclopedic reference for technical maintenance in the field: “In modern warfare the library accompanies even the most advanced fighting forces in the field.”²⁴

Within the wartime epistemology that viewed documents as containers for meaning, Shakespeare’s texts were subject to various kinds of encoding and decoding. Anti-Stratfordian hobbyists had searched for ciphers within Shakespeare’s texts since the nineteenth century, and cryptography was a long-established profession, but World War II’s impact on cryptanalysis was to raise the stakes of analyzing documents such that human lives depended on the flow

²¹ W. H. Auden, “Under Which Lyre: A Reactionary Tract for the Times,” in *Collected Poems*, ed. Edward Mendelson (London: Faber and Faber, 2007), 333–34.

²² Ronald E. Day, “The ‘Conduit Metaphor’ and the Nature and Politics of Information Studies,” *Journal of the American Society for Information Science and Technology* 51 (2000): 805–11.

²³ Michael S. Mahoney, “Cybernetics and Information Technology,” in *Companion to the History of Modern Science*, ed. R. C. Olby, G. N. Cantor, J. R. R. Christie, and M. J. S. Hodge (London: Routledge, 1990), 537–53; and Peter Galison, “The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision,” *Critical Inquiry* 21 (1994): 228–66.

²⁴ Vernon D. Tate, “Microphotography in Wartime,” *Journal of Documentary Reproduction* 5.3 (1942): 129–38, esp. 133.

and interception of coded information. During the war, Shakespeare's texts became code-bearing patterns of information in contexts far more consequential than the imaginations of Baconians and Oxfordians. According to Alice Brittan, "The most famous works of Shakespeare, Keats, Tennyson, Molière, Racine, and Rabelais became favorites among the Allied spies; they were easy for agents to remember, even under duress, because they were taught and studied in schools as exemplars of English or French literature."²⁵ Milton's image of Shakespeare's "easie numbers" takes on new meaning in light of these uses of Shakespeare's texts, which nonetheless depend upon the "deepe Impression" of the texts in the national consciousness. As Brittan suggests, "A British agent who as a student was asked to memorize Shakespeare's sonnet 55, or to write an essay in defense of its claim to immortality, could use the poem's opening lines—'Not marble, nor the gilded monuments / Of princes shall outlive this powerful rhyme'—to send information in defense of the country that claimed Shakespeare as its national bard. Code makers believed that the agent would recall this sonnet even in panic, because to forget was virtually an act of treason."²⁶ We can see a type of Shakespearean code existing independently of the authorship debates in a bibliographic strain distinguishable from, although obviously related to, the better-known wartime recruitment of plays like *Henry V* to bolster English patriotism.²⁷

Just as Shakespeare's texts became a sort of informatic weapon, so did wartime information techniques come to the rescue of Shakespeare. Former U.S. Army cryptanalysis experts William F. and Elizabeth S. Friedman became two of the most respected debunkers of anti-Stratfordian cipher theories in their 1958 book *The Shakespearean Ciphers Examined*.²⁸ Cambridge University Press's dust-jacket description takes pains to establish the Friedmans not only as neutral arbiters of the authorship debate because of their dissociation from the academy, but also as expert witnesses on the subjects of cryptography, in light of their wartime achievements. Supposedly, the minds that helped break Japan's Purple Code had found a suitable postwar challenge in theories about Shakespeare's texts, and their book represents a form of textual and informatic

²⁵ Alice Brittan, "War and the Book: The Diarist, the Cryptographer, and *The English Patient*," *PMLA* 121 (2006): 200–13, esp. 203; and Leo Marks, *Between Silk and Cyanide: A Codemaker's War, 1941–45* (1998; repr., New York: Touchstone, 2000), 11–12.

²⁶ Brittan, 203–4.

²⁷ For example, see Ton Hoenselaars, "Shooting the Hero: The Cinematic Career of *Henry V* from Laurence Olivier to Philip Purser," in *World-Wide Shakespeares: Local Appropriations in Film and Performance*, ed. Sonia Massai (London: Routledge, 2005), 80–87.

²⁸ William F. Friedman and Elizabeth S. Friedman, *The Shakespearean Ciphers Examined: An Analysis of Cryptographic Systems Used as Evidence that Some Author Other than William Shakespeare Wrote the Plays Commonly Attributed to Him* (Cambridge: Cambridge UP, 1958).

rationalism confronting the irrationalism of anti-Stratfordian cipher hunting. Cryptographic historian David Kahn uses especially vivid terms to describe the Friedmans' encounter with the anti-Stratfordian cryptographic imagination in search of provable ciphers: "They find no such proof. But they have a fascinating trip. They pass through a surrealist landscape where logic and the events of history both resemble and do not resemble the real things, like the oozing watch of Salvador Dali, where supermen of literature outperform the most harried of hacks in volume and the most thoughtful of philosophers in profundity—and then sit up nights enciphering secret messages to tell about it."²⁹ If the world of Baconian ciphers looks like a Dali landscape, the world of authentically Shakespearean code must be defined by right angles, with messages squared away and objects in their proper spatial relations.

The rational world of code represented by the Friedmans was also the one occupied by Bowers and Hinman during their years as cryptanalysts for the U.S. Navy from 1942 to 1945. The connections between their wartime cryptanalytical expertise and their postwar advances in compositor analysis are noted by G. Thomas Tanselle in his retrospective of Bowers's career. Tanselle observes that even prior to the United States's entry into the war, Bowers had received "secret instruction as a cryptanalyst in a naval communications intelligence group" at the University of Virginia; during the war, he supervised a naval communications group working on Japanese ciphers.³⁰ Whatever the reason, Bowers's group was heavy with Shakespeareans, with Hinman a member, along with two other experts from the Folger Library staff (Giles Dawson and Ray O. Hummel). The congruence between Shakespearean bibliography and military cryptanalysis was only natural, according to Tanselle: "It seems appropriate that several of the scholars interested in analytical bibliography after the war, including the two leaders of the field (Bowers and Hinman), spent their wartime years performing cryptanalytic work together, for the goal of both activities is to find meaningful patterns in what at first seem to be chaotic data, and the bent of mind required for both is obviously similar."³¹

Noting the war's disruption of scholarly work, Jeffrey Masten takes these links further by arguing that "compositor analysis wasn't so much suspended as *produced* by the war," part of a paranoid culture of error detection that also

²⁹ David Kahn, *The Codebreakers: The Comprehensive History of Secret Communication from Ancient Times to the Internet*, rev. ed. (New York: Scribner, 1996), 879; see also Shawn James Rosenheim's chapter "Deciphering the Cold War: Toward a Literary History of Espionage," in *The Cryptographic Imagination: Secret Writing from Edgar Poe to the Internet* (Baltimore: Johns Hopkins UP, 1997), 139–70, esp. 151.

³⁰ G. Thomas Tanselle, "The Life and Work of Fredson Bowers," *Studies in Bibliography* 46 (1993): 1–154, esp. 32–33.

³¹ Tanselle, 34.

encompassed the detection of supposed communists and homosexuals hiding within the ranks of U.S. government service.³² Responding to Tanselle's comment about finding "meaningful patterns in . . . chaotic data," Masten asserts, "Surely there are other questions to ask: what are the differences between intentionally produced codes disclosing the locations of Japanese warships, and the codes, or inscriptions, of seventeenth-century spellings? What if chaotic data . . . is instead data that lies outside our standards for the behavior of the chaotic and ordered?"³³ With these questions, Masten raises concerns that join the cultural construction of information with the basic principles of information theory. As a universal theory of human communication, the model proposed by Shannon and Weaver should encompass encoded reports of troop movements and imprinted words in early modern spelling with equal ease, supposedly proving that what matters most is the underlying sameness, not particularity, of different forms of information. This perception of information's role in the standardization of communication—now a core concept in standards-based digital humanities projects—is fundamentally mechanistic and has as much to do with the machines of Shakespeare's time as with those of today. Cybernetics emerged as a science at the same time that Shakespearean bibliographers made a concerted turn toward compositor analysis, the study of human-machine interface in the printing house, in order to understand the manuscripts behind Shakespeare's Folio and quartos. For cyberneticists like Wiener, the human-machine interface between a gunner and his antiaircraft system is measurable and predictable in the same ways that the interface between an early modern compositor and the apparatuses of the press are for Hinman. In particular, analytical bibliography could be regarded as the study of the threshold spaces where the human meets the mechanical, and where the two function together in a system of textual transmission that is complex, variable, and yet (to a degree) predictable. For example, the *New Bibliography's* chronicler, F. P. Wilson, wrote in 1945 that

it is often imperative to resort to hypothesis and conjecture, but often, as we have seen, the bibliographer reaches conclusions that are demonstrable and irreversible. The reason is that he is dealing with an Abel Jeffes or a James Roberts not in his relations with other human beings, whether of the government, or the Stationers' Company, or the playhouse, but in *his relations with a mechanical process*. Strange accidents can indeed happen to type, and human

³² Jeffrey Masten, "Pressing Subjects; Or, the Secret Lives of Shakespeare's Compositors," in *Language Machines: Technologies of Literary and Cultural Production*, ed. Jeffrey Masten, Peter Stallybrass, and Nancy J. Vickers (New York: Routledge, 1997), 75–106, esp. 88.

³³ Masten, 88.

error plays its part in causing them, but the accidents are often analysable and explicable with a completeness that approaches mathematical proof.³⁴

It would have been difficult to conceive of a human relationship with a mechanical process in this way prior to cybernetics, except perhaps in analytical bibliography, which may explain why the two fields seem so congruent after the late forties.

There is a good fit between these knowledge domains not only in terms of “bent of mind,” as Tanselle claims, but also between their technological applications. A bit of disciplinary history well known to Shakespearean bibliographers is that Hinman’s photographic collating device, an indispensable tool in his subsequent research on the First Folio, had its genesis partly in his wartime intelligence experience. As Steven Escar Smith relates, Hinman’s work with the cryptanalysis group likely exposed him to stories about experiments in optical comparison of aerial surveillance photographs of enemy emplacements. From these stories and prior bibliographic experiments in mechanical collation, Hinman drew the underlying principles that linked photography, mechanical collation, and human cognition.³⁵ To look through the eyepiece of a Hinman Collator—one of which still sits in the reading room of the Folger Shakespeare Library—and see a press variant blinking on and off, as though the Folio page before you were itself digital, is to become part of one human-machine interface built to decode patterns of impression left by another, the printing house of William and Isaac Jaggard.

Mid-century bibliography and information theory were thus caught up in the same emergent tendency to regard texts as virtual.³⁶ Their concern with the Shakespeare text as an information pattern latent in physical documents manifested itself in the profiling of hypothetical manuscript copy behind real printed books, as well as the profiling of the work habits of the compositors who read and set from that copy. Kirschenbaum points out that “for both textual scholars and information theorists the immediate post-war years were a period dedi-

³⁴ F. P. Wilson, *Shakespeare and the New Bibliography*, rev. ed., ed. Helen Gardner (Oxford: Clarendon Press, 1970), 34 (emphasis added).

³⁵ Steven Escar Smith, “‘The Eternal Verities Verified’: Charlton Hinman and the Roots of Mechanical Collation,” *Studies in Bibliography* 53 (2000): 129–61, esp. 136–38.

³⁶ On prewar tendencies toward information theory in bibliography, see Kirschenbaum, “Editing the Interface”; and Laurie E. Maguire, *Shakespearean Suspect Texts: The “Bad” Quartos and Their Contexts* (Cambridge: Cambridge UP, 1996), 21–71. Recent examples of literary scholars using information theory include Clod, “Information”; Peter M. W. Robinson, “Is There a Text in These Variants?” in *The Literary Text in the Digital Age*, ed. Richard J. Finneran (Ann Arbor: U of Michigan P, 1996), 99–115; and Tom Davis, “The Monsters and the Textual Critics,” in *Textual Formations and Reformations*, ed. Laurie E. Maguire and Thomas L. Berger (Newark: U of Delaware P, 1998), 95–111.

cated to codifying their respective disciplinary methodologies,” and he suggests that Greg’s treatment of accidentals and substantives in his theory of copy-text editing resembles the kind of thinking occurring at the same time in information theory.³⁷ While Kirschenbaum reports finding no direct historical links, I suggest that we do not necessarily need evidence of direct communication for there to be epistemological links of consequence to textual studies and digital humanities in the present. Although the New Bibliographers were not necessarily doing information theory, they were involved in analogous textual sciences.

The pattern of analogy also extends to their failures, especially their failure to account for the complex connections between what texts mean and how acts of communication—whether editing, performance, digitization, or rare book exhibitions—generate new meanings in their reception. This history is worth knowing about as current Shakespeare digitization projects come of age, and as new ones take shape. Ironically, the idea that an edition is less like an archive (in preserving received meanings) and more like a performance (in inventing new ones) may be more technically feasible in a digital edition than in print, and yet less “thinkable” in Michel de Certeau’s sense of the word. As de Certeau argues, historical projects generally tend in one direction or another: “One type of history ponders what is comprehensible and what are the conditions of understanding; the other claims to reencounter lived experience, exhumed by virtue of a knowledge of the past.”³⁸ These two tendencies are not necessarily in opposition, but they are in tension. My argument so far is that new media do not, through any essential character, enhance what de Certeau calls history’s capacity “to render thinkable the documents which the historian inventories”;³⁹ when they do, it is mainly by virtue of the encoder’s conscious agency, which represents a deliberate choice about how to respond to the histories digital tools carry with them. Both of de Certeau’s historical tendencies—and their tensions—are present in digital Shakespeare projects and in their antecedents described above, but the question is whether and how digital tools render Shakespeare’s texts as either conduits to the past or conditions of possibility. In considering this question, however, we should first account for Shakespeare’s strange predominance as an exemplar in information theory itself.

³⁷ Kirschenbaum, “Editing the Interface,” 19–20n12.

³⁸ Michel de Certeau, *The Writing of History*, trans. Tom Conley (New York: Columbia UP, 1988), 35.

³⁹ De Certeau, 35.

III. SHAKESPEARE AND THE DEFINITION OF INFORMATION

In this new theory the word information relates not so much to what you *do* say, as to what you *could* say. That is, information is a measure of your freedom of choice when you select a message. . . . The two messages between which one must choose in such a selection can be anything one likes. One might be the King James version of the Bible, and the other might be “Yes.”
—Warren Weaver, “The Mathematics of Communication”⁴⁰

Thou shalt commit adultery.
—King James Bible (1631)⁴¹

[³yes³] I said [²yes²] I will [³[yes.] Yes.³]
—James Joyce, *Ulysses* (synoptic edition)⁴²

I have used the term *information theory* to refer to a field of study—but what exactly is the theory to which some humanities scholars have objected so categorically when applied to cultural texts? Before moving on to the theory’s consequences in the present, this section briefly summarizes information theory in its classical form, that of Claude Shannon’s communications model as outlined by Warren Weaver’s landmark essay, “The Mathematics of Communication.” The model describes how a message travels from an information source to its destination, and how any changes resulting from the intervention of noise are subject to laws of probability. The components of the communications model, in sequence, are the *information source*, *transmitter*, *channel*, *receiver*, and *destination* (Figure 1). As Weaver summarizes the theory, “The information source selects a desired message out of a set of possible messages. . . . The transmitter changes [encodes] this message into a signal which is sent over the communication channel to the receiver,” at which point a reverse process takes place in which “the receiver is a sort of inverse transmitter, changing the transmitted signal back into a message, and handing this message on to the destination.”⁴³ The process may seem simple enough, but information theory identifies two areas where

⁴⁰ Warren Weaver, “The Mathematics of Communication,” *Scientific American* 181.1 (1949): 11–15, esp. 12.

⁴¹ From the infamous reprint known as the Wicked Bible (London, 1631); see *The Holy Bible containing the Old Testament and the Nevv* (London: Robert Barker . . . and by the assignes of John Bill, 1631), Exodus 20.14; and David Norton, *A Textual History of the King James Bible* (Cambridge: Cambridge UP, 2005), 95–96.

⁴² James Joyce, *Ulysses: A Critical and Synoptic Edition*, prep. Hans Walter Gabler with Wolfhard Steppe and Claus Melchior, 3 vols. (New York: Garland, 1986), 3:1726.

⁴³ Weaver, 11–12.

complexity intervenes. One is the communication channel, where the signal may change in ways the information source did not intend: “These unwanted additions [to the signal] may be distortions of sound (in telephony, for example), or static (in radio) . . . or errors in transmission (telegraphy or facsimile). All these changes in the signal may be called noise.”⁴⁴

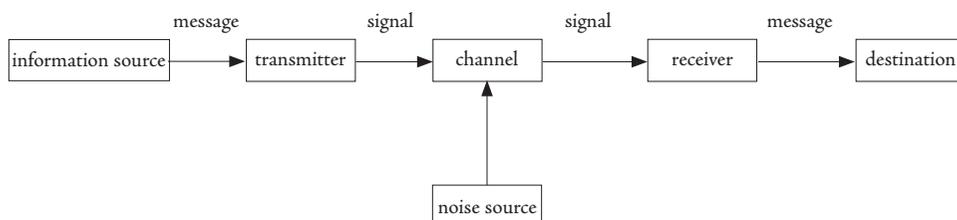


Figure 1: Shannon and Weaver’s mathematical model of communication.

A Shakespearean example may help to both illustrate and complicate the model. In his anti-Stratfordian excursus *Is Shakespeare Dead?* Mark Twain recounts how one Captain Ealer (on whose riverboat Twain apprenticed in his youth) would recite Shakespeare from memory in the wheelhouse, interlaced with running commentary on Twain’s helmsmanship such that “if we were in a risky and difficult piece of river an ignorant person couldn’t have told, sometimes, which observations were Shakespeare’s and which were Ealer’s.”⁴⁵ Recalling Ealer’s jumbled recitation of a speech from *Macbeth*, 3.4, Twain gives an example of two mixed messages, each functioning as noise to the other:

What man dare, *I* dare!

Approach thou *what* are you laying in the leads for? what a hell of an idea! like the rugged ease her off a little, ease her off! rugged Russian bear, the armed rhinoceros or the *there* she goes! meet her, meet her! didn’t you *know* she’d smell the reef if you crowded it like that? Hyrcan tiger; take any shape but that and my firm nerves she’ll be in the *woods* the first you know! stop the starboard! . . . *Now* then, you’re all right; come ahead on the starboard; straighten up and go ’long, never tremble: or be alive again, and dare me to the desert *damnation* can’t you keep her away from that greasy water? pull her down! snatch her! snatch her baldheaded! with thy sword; if trembling I inhabit then, lay in the leads!—no, only the starboard one, leave the other alone, protest me the baby of a girl. Hence horrible shadow! eight bells—that watchman’s asleep again, I reckon, go down and call Brown yourself, unreal mockery, hence!⁴⁶

⁴⁴ Weaver, 12.

⁴⁵ Mark Twain, *Is Shakespeare Dead?* (New York: Harper, 1909), 5.

⁴⁶ Twain, 5–6.

While Ealer fulfills Milton's prophecy of readers who monumentalize Shakespeare through the deep impressions of memory, Twain himself falls short as the noise of the world intervenes. He laments, "It was a damage to me, because I have never since been able to read Shakespeare in a calm and sane way. I cannot rid it of his explosive interlardings, they break in everywhere."⁴⁷ This story captures the core concerns of information theory, including the "damage" Twain experiences as a result of the tangled messages and the command-and-control scenario as the wheelhouse crew, functioning as a single system, responds to results of its own actions ("ease her off!"; "there she goes!").

The Babel persisting in Twain's memory is an example of the Shakespeare text assimilating itself to the condition of information, and its comic effect depends upon the reader's impulse to disentangle the recognizably Shakespearean language—an impulse repeatedly frustrated by the ease with which the one message slips into the other, aided by the imperative phrasing which makes Twain himself into the ghost of Banquo by the end ("go down and call Brown yourself, unreal mockery, hence!"). The reader of this passage cannot help but relive the Shakespeare editor's eternal dilemma, compounded by Twain's implicit expectation that the original text of *Macbeth* should be deeply impressed in the reader's own memory. The whole text of the passage might be considered a signal, in Shannon's terms, but whether the recollected text of *Macbeth* or the navigational instructions are message or noise depends on what one considers important—that is the crux of Twain's joke. What we call noise may be only a function of competing intentions and agencies.

Another area of complexity, and perhaps the most counterintuitive aspect of information theory, is the definition of information. To be clear: *information* in information theory means something very different from what it does in most everyday usage. In Shannon's model, information is not a thing, or a quality of things corresponding to *meaning* or *truth* or *accuracy*, but rather a measure of the disambiguation required to express an intelligible message. Gregory Bateson uses the example of writing systems: "An event or object such as the letter K in a given position in the text of a message *might* have been any other of the limited set of twenty-six letters in the English language. The actual letter excludes . . . twenty-five alternatives. In comparison with an English letter, a Chinese ideograph would have excluded several thousand alternatives. We say, therefore, that the Chinese ideograph carries more information than the letter."⁴⁸ As Weaver was often at pains to emphasize, "The concept of information applies not to the individual messages, as the concept of meaning would, but rather to the situa-

⁴⁷ Twain, 6–7.

⁴⁸ Gregory Bateson, *Steps to an Ecology of Mind* (1972; repr., U of Chicago P, 2000), 408.

tion as a whole.”⁴⁹ Information in this sense is thus a measurable quantity within a definable system, not an interpretive quality lurking within an individual text or artifact.

The ideological dimensions of information theory have been well documented by Geoffrey Nunberg, Hayles, and others in recent years, but less recognized is Shakespeare’s centrality to this theory as a touchstone. Shakespeare appears in the theoretical discourse about information and computing from the beginning, even in one of the founding works of modern computing, mathematician Alan Turing’s 1950 essay “Computing Machinery and Intelligence.”⁵⁰ One of the first serious scientific discussions of artificial intelligence, this essay proposes criteria for what has become known as the Turing test, a scenario in which a human judge converses with a hidden interlocutor who may be another human or a machine; if the judge cannot tell which is which, the machine has passed the test. Notably, Turing envisions this test partly in terms of a “sonnet-writing machine” that could simulate what he regards as an essentially human mode of communication.⁵¹ Taking an example from Shakespeare’s Sonnet 18 (“Shall I compare thee to a summer’s day?”), he equates Shakespeare with an aspect of human communication that his audience might regard as exceeding the machine’s capacity for modeling.

These very conditions materialized in an actual Turing test in 1991 at the Boston Computer Museum, in which ten human judges conversed via keyboard and screen with six artificial intelligence programs and four human confederates, with the confederates’ and computers’ identities concealed. Shakespeare again showed up among the topics of conversation selected for the test, along with “dry martinis,” “women’s clothing,” and other topics “of the sort appropriate for a cocktail party,” as one of the referees recounts.⁵² An episode of the PBS series *Scientific American Frontiers* captured some of the conversations between the judges and a human confederate, Cynthia Clay, whose knowledge of Shakespearean matters such as the authorship complexities of *Pericles* unexpectedly reversed the dynamics of the Turing test: judges and audience members misidentified her as a computer.⁵³ One audience member reasoned, “Some of [Clay’s] answers seemed too studied, as if they were somehow canned opinions that came from a large database”; similarly, a judge thought no human could command so much

⁴⁹ Weaver, 12.

⁵⁰ A. M. Turing, “Computing Machinery and Intelligence,” *Mind* n.s. 59 (1950): 433–60.

⁵¹ Turing, 446.

⁵² Stuart M. Shieber, “Lessons from a Restricted Turing Test,” *Communications of the Association for Computing Machinery* 37.6 (1994): 70–78, esp. 72.

⁵³ “Machines Who Think: Contest and Competitions,” *Scientific American Frontiers*, season 2, episode 5; broadcast 23 October 1991, <http://www.pbs.org/saf/> (accessed 12 August 2010); see also Shieber, 72.

information about Shakespeare. The subtext of the episode is revealing. Clay's good-humored but exasperated response—"People, go to school!"—highlights the ostensible status of Shakespeare information as a kind of public commons, like baseball statistics, but also hints at a decline in public knowledge of Shakespeare.⁵⁴ By the time computing had advanced to the stage where a real Turing test was viable, a person like Clay was an anomaly, and her personal command of information on Shakespeare was most readily explained in computational terms. Between 1949 and 1991, Shakespeare had become an information domain where the boundary between human and machine was contested.

The Turing example is no exception, but part of a pattern in explanations of information as a measure of disambiguation rather than a quantity of knowledge. G. H. Hardy's *A Mathematician's Apology* (1940), while predating information theory as such by a few years, nonetheless sets the tone by using Shakespeare's texts to explain the difference between pure and applied mathematics. Hardy argues that it would be fallacious to suppose that our understanding of a theorem was affected by the physical character of the means we use to represent it, like imperfectly drawn shapes on a lecture-hall blackboard: "It would be like supposing that a play of Shakespeare is changed when a reader spills his tea over a page. The play is independent of the pages on which it is printed, and 'pure geometries' are independent of lecture rooms, or of any other detail of the physical world."⁵⁵

Similar idealism appears in a 1956 book by one of the founders of information theory, physicist Léon Brillouin, who mentions Shakespeare when he explains (following Shannon) that information theory does not deal with "the human value of the information," or what we might call meaning, but only with the quantifiable behavior of information in a communications system.⁵⁶ Brillouin states that we can quantify the amount of information in any arbitrary string of 100 letters, regardless of whether they are (in his words) "a set of 100 letters selected at random . . . a sentence of 100 letters from a newspaper, a piece of Shakespeare or a theorem of Einstein."⁵⁷ Information is to be distinguished from knowledge, with knowledge represented by Einstein, Shakespeare, and a newspaper. Compare this comment from the unpublished 1959 notebook of French biologist Jacques Monod: "From the point of view of the theory of information, the works of Shakespeare, with the same number of letters and signs aligned at random by a monkey, would have the same value. . . . What

⁵⁴ "Machines Who Think: Contest and Competitions."

⁵⁵ G. H. Hardy, *A Mathematician's Apology* (1940; repr., Cambridge: Cambridge UP, 2001), 126.

⁵⁶ Léon Brillouin, *Science and Information Theory*, 2d ed. (1962; repr., Dover Phoenix, 2004), 9.

⁵⁷ Brillouin, 9.

could be considered as 'objective' in the Shakespearean information that would distinguish it from the monkey's information? Essentially the transmissibility."⁵⁸ Monod alludes to the commonplace idea of infinite monkeys at typewriters reproducing the works of Shakespeare by accident, although in popular culture Shakespeare's texts have somehow substituted themselves for the books in the British Museum, which was the original example popularized by British physicist Arthur Eddington.⁵⁹

These are just a few examples among many.⁶⁰ The pattern that emerges reveals certain assumptions: Shakespeare is ideal text, not material text or performance; the plays are the products of a single authorial source (Cynthia Clay was unwilling to discuss *The Two Noble Kinsmen* as a coauthored play and correctly guessed that human judges would not recognize the collaborative play *Pericles*); these texts themselves possess no more internal complexity of transmission than any other book on the shelf; and despite whatever cultural power we may locate in Shakespeare—what Brillouin calls "the human value"—information theory holds a greater power to make information strategically mobile by asserting a fundamental equivalency between all texts.

Information theory's claims for Shakespeare's *unexceptionality* might seem as provocative as Benjamin Jowett's controversial claim a century earlier that the Bible could be interpreted "like any other book," but this approach also resonates with the contemporary thinking about literary texts that was coming from the New Bibliographers.⁶¹ F. P. Wilson's 1945 work *Shakespeare and the New Bibliography* exemplifies this sympathy in a brash claim which echoes the spirit of the Weaver epigraph above: "To a formal bibliographer a book is not the life-blood of a master spirit but a collection of pieces of paper with printing on them."⁶² This hearkens back to W. W. Greg's dictum: "What the bibliographer is concerned with is pieces of paper or parchment covered with certain written or printed signs. With these signs he is concerned merely as arbitrary marks; their

⁵⁸ Quoted in Lily E. Kay, *Who Wrote the Book of Life? A History of the Genetic Code* (Stanford: Stanford UP, 2000), 220.

⁵⁹ Terry Butler, "Monkeying Around With Text," *TEXT Technology* 15.1 (2007): 113–33.

⁶⁰ See also Jagjit Singh, *Great Ideas in Information Theory, Language, and Cybernetics* (New York: Dover, 1966), 209; David Layzer, *Cosmogogenesis: The Growth of Order in the Universe* (Oxford: Oxford UP, 1990), 31; William A. Dembski, *The Design Inference: Eliminating Chance through Small Probabilities* (Cambridge: Cambridge UP, 1998), 216; David J. C. MacKay, *Information Theory, Inference, and Learning Algorithms* (Cambridge: Cambridge UP, 2003), 490; and Hubert P. Yockey, *Information Theory, Evolution, and the Origin of Life* (Cambridge: Cambridge UP, 2005), 5.

⁶¹ Benjamin Jowett, "On the Interpretation of Scripture," in *Essays and Reviews: The 1860 Text and Its Reading*, ed. Victor Shea and William Whitla (Charlottesville: U of Virginia P, 2000), 477–594, esp. 504 (emphasis removed).

⁶² Wilson, 42.

meaning is no business of his.”⁶³ Such bracketing of meaning for the purpose of determining a mechanical process mirrors Shannon’s similar gesture in most respects, including its contentiousness in the eyes of critics.

The indivisibility of encoding from meaning is no surprise to Shakespeare editors, who have long wrestled with received text that sometimes wavers on the border between sense and nonsense. A major blind spot in Shannon and Weaver’s communications model—at least as it applies to literature, as it supposedly does to all human communication—is its mistaking of where complexity lies, not just in signal and noise but especially in encoding and decoding.⁶⁴ This mistake accounts for a problematic tendency in humanities computing: the assumption that the encoding of humanities material into machine-readable form should be straightforward, subject to a global set of rules underpinned by rationality and consistency. Whatever virtues computing humanists might make of encoding as a field for inquiry and illuminating problems, day-to-day practice feels the pressure of information theory’s legacy: the technical assumption, even cultural conviction, that a text can be transmitted, encoded, and received with little difficulty so long as noise, ambiguity, and error are minimized to acceptable levels.

What is at stake here, and throughout digital Shakespeare projects today, is the validity of the idea of Shakespeare as code—not just as cultural code, in the semiotic sense, but also as the machine-readable code that makes computing possible, which Hayles defines as the “system of correspondences that relate the elements of one symbol set to another symbol set, [as] for example, when Morse code associates dots and dashes with alphabetic letters. Unlike Morse code, however, code within the computer is *active*, for it functions as instructions that initiate changes in the system’s behavior.”⁶⁵ This essay has described some of the historical conditions in which Shakespeare’s texts became active machine-readable code, as distinct from stable, passive data to be acted upon. In all of these instances—the code-bearing sonnets of Allied spies; the code-breaking mindsets of Hinman, Bowers, and the Friedmans; the New Bibliographers’ proto-cybernetic interest in the human-machine interface of the early modern printing press—a kind of informatic sublime takes shape in which the words and bibliographic features of Shakespeare’s texts assume special status even as they affirm their transmissibility within universal systems. In this view, Shakespeare’s

⁶³ Greg, “Bibliography—An Apologia,” 141.

⁶⁴ N. Katherine Hayles, “The Future of Literature,” public plenary session for the symposium “Literature, Culture, and the Digital Artifact,” University of British Columbia, Vancouver, 13 January 2006.

⁶⁵ N. Katherine Hayles, *My Mother Was a Computer: Digital Subjects and Literary Texts* (Chicago: U of Chicago P, 2005), 108.

texts hold a surplus of meaning that exceeds the capacities of any medium yet also underwrites the authenticity of the transmission. Combined with this Shakespearean transmissibility in the wake of information theory is the desire for regularity embodied by Shannon and Weaver's communications model, in which we can find analogues in Hinman's and Bowers's cryptanalytic missions to find meaningful patterns in chaotic data, and even in Greg's determination to see regularity and order in early modern documents like Henslow's diary (in his edition, Greg normalized all Sunday performances to fall on other days, on the assumption that theatre performances on Sundays were not permitted).⁶⁶

What makes Shakespeare such a fraught case for digitization is that minimizing static (to mix digital and analogue metaphors) escalates from a technical possibility to a cultural imperative, and indeed to a defense of a culture that imagines itself under threat. Once information theory extends itself into questions of culture, it can no longer separate the solving of problems from the bestowing of value. Ronald Day argues that we see such values at work "in the privilege that a certain 'factual' and 'clear' information is given in communication (in writing in general, in the media, in organizations, in education, and in politics), in the demand that the arts represent reality rather than 'distort' it (realism), and even in the claim that history is the transmission of the past to receivers in subsequent generations (cultural heritage)."⁶⁷ In the logic of information theory, Shakespeare's texts would be received as clear transmissions if only we could eliminate the noise on the line. The digitization of Shakespeare's texts thus represents the meeting of two culturally constructed essentialisms: Shakespeare idealized as transmissible heritage sublimated into digital networks as idealized communications channels.

IV. SHAKESPEARE AFTER COMPUTING ESSENTIALISM

Does the cultural logic of computation, as implemented through information theory, necessarily define the essence of computers, as received devices?⁶⁸ I would say in the end it does not, but also that we are after computing essentialism in the same sense in which we are after theory: both chronologically subsequent to it and therefore inheriting it and (at the same time) positioned to reevaluate it critically and move beyond its limits. The best means of resisting computing essentialism—and of awakening the humanistic imagination to the possibilities of computing—is history, both the historicizing of our own tools and practices, and the historicity of our materials. My purpose in this essay has been to show

⁶⁶ Maguire, 53–54.

⁶⁷ Day, 810.

⁶⁸ I borrow this phrase from the title of David Golumbia's *The Cultural Logic of Computation* (Cambridge, MA: Harvard UP, 2009).

that Shakespearean code and its deployment in computing emerged from specific historical circumstances, susceptible to ideological analysis and open to contestation. This means that embracing computing uncritically is just as dangerous as rejecting it uncritically, or supposing that there is any dimension of Shakespeare in the present that remains unaffected by the epistemology of computing. Worthen posits performance as a modern form of Shakespeare which cannot be reduced to information, but such an argument carries the dual risks of treating performance as its own kind of ineffable pure geometry (to paraphrase Hardy) and of overlooking the many digital projects which treat performance as archivable, preserving not the performance itself *in toto* but rather the records, documents, artifacts, and other material traces which may be represented digitally. The question is not whether drama is “assimilable to ‘information,’” as Worthen puts it (I believe it isn’t, for exactly the reasons he states); the question is how and why that assimilation takes place anyway—both in digital Shakespeare projects and in the cultural imagination—and what to do about it.

All this would be simpler if the metonymy of texts, practices, and imperatives we call *Shakespeare* was limited to performance as an unreachable quintessence. In practice, the Shakespeare metonym usually takes a messier hybrid form, entangling performances with documents, texts, technologies, information patterns, and the materials of that other capacious metonym, code. We should understand that entanglement as a kind of cultural work, a collective preoccupation with the virtuality of the received texts that implicates all aspects of digital Shakespeare scholarship. Although I readily agree with critiques of the conduit metaphor of information—Tom Davis, echoing Karl Popper, gives it the even less salutary name “bucket theory”⁶⁹—simply rejecting the metaphor out of hand, or ignoring its influence on the transforming discipline, cannot be an adequate response. If we do not explicitly articulate, at a technical level, our intellectual relationships with digital tools, others will do it for us.

In articulating their relationship with digital tools, Shakespeare researchers should not feel constrained by the idea that these technologies are somehow inherently scientific instruments, on loan to the humanities on the condition that they be used scientifically (or pseudoscientifically, as is more often the case). The benefit of rejecting such constraints is that Shakespeareans do not have to carry the ideological baggage that Day describes and can think of applications for computing beyond the conservative preoccupation with canon policing, authorship attribution, and quantitative verification of qualitative interpretations. In many ways, it was unfortunate that the first widely publicized use of computing in Shakespeare studies was a question of authorship attribution, Don Foster’s computer-assisted analysis of the authorship of the “Funeral

⁶⁹ Davis, 106.

Elegy”—unfortunate not because of any particular deficiency in Foster’s methods (which I am not qualified to judge) but simply because the episode cast computers in their old postwar role as answer machines. Stephen Booth likely spoke for many Shakespeareans in his response: “As to the [computer] tests themselves, I don’t pretend to understand them.”⁷⁰ Who can blame him? In retrospect, it is difficult to see the past decade’s proliferation of social media and Web-based computing drawing much inspiration or energy from the “Funeral Elegy” episode. Even at the time, it seemed an old-fashioned use of computing (statistical analysis) applied to an old-fashioned critical question (authorship attribution in the service of regulating cultural heritage), fought out in divisive polemics that led nowhere.

“[T]hou shalt not sit / With statisticians nor commit / A social science” was W. H. Auden’s caustic response to the humanities’ postwar displacement by the sciences, part of a “Hermetic Decalogue” which includes another commandment regularly ignored by digital humanists today (myself included): “Thou shalt not worship projects.”⁷¹ Yet the message that computing brings an inevitable turn toward a positivist form of quantitative research—and, implicitly, away from other approaches favoring history, materiality, gender, ideology, and performance—is simply not true. Its promulgation within sectors of the digital humanities is less about recognizing the computer’s essential nature, and more about a disciplinary sleight-of-hand by which poststructuralist and materialist influences are displaced by an empiricism more amenable to the cyberinfrastructure model of big science and an administered world. The optimism that usually attends new media can lead us to forget that our everyday acts of individual communication, supported by mobile devices and social networks, are governed by master narratives which cannot go unquestioned. Digital encryption, for example, has become so ubiquitous as to seem mundane, but as Tarleton Gillespie describes, every encoded Tweet and Facebook update invoke a cultural history related to the one I have been describing: “The paradigmatic relationship between participants that encryption has required in its traditional application—secret military communication—is being forced upon public, commercial, and cultural exchanges that never before worked on such terms.”⁷² In this light, even the most mundane of digital interactions fulfills Auden’s fears by deepening the militarization of all human communication.

Yet, almost unaccountably, this “paradigmatic relationship” and its sustaining narrative install Shakespeare at its core, as we have seen, and thus become

⁷⁰ Stephen Booth, “A Long, Dull Poem by William Shakespeare,” *Shakespeare Studies* 25 (1997): 229–37, esp. 237.

⁷¹ Auden, *Collected Poems*, 337–38.

⁷² Tarleton Gillespie, *Wired Shut: Copyright and the Shape of Digital Culture* (Cambridge, MA: MIT Press, 2007), 248.

vulnerable to contestation and the unexpected. Recruiting Shakespeare to any cause—political, religious, aesthetic, disciplinary—can have unforeseen consequences, as every modern performance has the potential to show us. For this reason, if no other, I believe that optimism about new media is thoroughly warranted, even if it is the cautious kind. As Mahoney argues, computing is not an alien technology which impacts a discipline from some distant beyond, like a meteorite hitting the earth, but rather a set of practices which have long been adapted and reinvented by different communities for their own purposes.⁷³

Shakespeareans are no exception. Some of the most promising digital Shakespeare projects use information-based approaches to emphasize discovering over verifying. For example, the newer generation of text-analysis scholarship, represented in this issue by Jonathan Hope and Michael Witmore, recognizes that objective—or at least quantified—testing of subjective arguments is probably not why most humanists would find iterative or algorithmic criticism valuable. They use statistical methods not to answer questions or verify qualitative hypotheses, but rather to discover and refine questions. Their approach embraces hermeneutics instead of replacing it, as many older, positivistic approaches in computational stylistics attempted to do without success. What mainstream Shakespeareans are more likely to need are interpretive approaches that help us refine our subjectivity, whether by finding unexpected patterns that require interpretation or by extending an inference on a scale that reading alone cannot permit. To return to de Certeau's terms, these kinds of projects use digital tools to model our own "conditions of understanding" of Shakespeare's texts.⁷⁴

A persistent problem for many such projects, however, is their dependence on the transmissibility narrative that underwrites digitized texts like the Moby Shakespeare, derived from the 1864 Globe edition, as Andrew Murphy describes elsewhere in this issue. The larger the scale of the analysis, the more likely it is that some version of the Shannon and Weaver model of information will govern the project's thinking about the transmission of texts, with author and reader equivalent to sender and receiver. Some text-analysis scholars regard objections to their approach as unnecessary wrangling about which edited text is the most suitable for statistical analyses, and point out that modern editions do not vary all that much.⁷⁵ Yet many agents, not just the author, are entangled with the histories and meanings of texts. Theorists of text and performance alike have been pointing this out for years. More is at stake, therefore, in objections to the Moby Shakespeare than the question of which text is the most authoritative. At issue is whether or

⁷³ See n. 18 above.

⁷⁴ De Certeau, 35.

⁷⁵ Martin Mueller, "The Nameless Shakespeare," *TEXT Technology* 1 (2005): 61–70.

not certain computational approaches preclude de Certeau's kind of history—inquiring into what makes historical documents thinkable in the first place.

Other projects like the Internet Shakespeare Editions, the MIT Shakespeare Electronic Archive, and the Electronic New Variorum Shakespeare self-consciously deal with materials that resist straightforward digital representation and modeling.⁷⁶ The resulting gap between representation and artifact is the kind of space where humanists work best. Using the terms of information theory, we could say that all of these projects focus on noise, not just message. These projects treat Shakespeare's texts not as signals from the past to be purged of interference, but as bearers of impressions made by nonauthorial agents (collaborators, players, audiences, readers, editors) that intervened in the material and cultural histories of Shakespeare's works. Yet for all their historical and archival particularity, these projects do not push computational limits the way that analytical and three-dimensional modeling projects do, and they do not yet exploit the scalability of computing. What would digital Shakespeare criticism look like if the digital tools supporting it could also account for the complexity of textual transmissibility? That is an exciting prospect to contemplate. More to the point, it is a viable goal for Shakespeareans who are not content to be impacted by new media but would rather fashion their own forms of computing.

As one of those intervening agents, Milton reminds us that technical challenges like digital preservation and interface design may be understood through the lenses offered by literature, in which the rational and the irrational can be in focus simultaneously, resulting in a useful blurring of distinctions between form and content, text and reader, interface and data—just as meanings of the word “numbers” overlap in a postdigital reading of Milton's own poem. The note of potential loss that Milton sounds resonates with one of the strongest themes shared by Shakespeareans and information theorists alike: anxiety about what is recoverable and what is irrevocably lost in the material transmission of texts. The power of that very anxiety must have struck Milton as he looked back to the First Folio, one of the first great experiments in interfaces for the Shakespeare texts, along with the Elizabethan public playhouse itself. Milton's epitaph validates a kind of readerly collaboration in the continuance of the Shakespeare text: the leaves of Shakespeare's “unvalued book” are a preservation format, but only when they provoke a further circulation of texts among communities of readers, building networks of “deep impression.” As Milton's poem suggests, Shakespearean information persists only through transmissibility in numbers yet unknown.

⁷⁶ On these three projects, see the special issue “Reinventing Digital Shakespeare,” ed. Alan Galey and Ray Siemens, *Shakespeare* 4.3 (2008), especially Paul Werstine, “Past Is Prologue: Electronic New Variorum Shakespeares,” 208–20; Michael Best, “The *Internet Shakespeare Editions*: Scholarly Shakespeare on the Web,” 221–33; and Peter S. Donaldson, “The Shakespeare Electronic Archive: Collections and Multimedia Tools for Teaching and Research, 1992–2008,” 234–44.