Cybertextuality

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Abstract

"Cybertexts are the pairs of utterance-message and feedback-response that pass from speaker-writer to listener-reader, and back, through a channel awash with noise. Cybertextuality is a broad theory of communication that draws on the cybernetics of Norbert Wiener (1894-1964) to describe how we manage these dual message-feedback cybertexts into being and that helps explain the publishing, the transmission, and the reception of all speech and text. Recursiveness, complexity, and homeostasis are three principles of cybertextuality. Because we are cognitively blind to how we create most utterances (language belongs to procedural memory, which can be recalled only by enacting it), we unselfconsciously model even our own language acts (not just ones by other people) simply in order to recognize and revise them. We observe or receive our own language acts before anyone else does. Our feedback is to represent those acts meaningfully. Mental modelling, as a feedback mechanism, is recursive. Our every utterance or output serves as input to another (possibly silent) uttering. Messaging-feedback is also complex. It operates cognitively on phonetic, lexical, grammatical, semantic, and discourse levels of language and often handles different utterances simultaneously. However, cybertextual cycling serves us well. It is a dynamic, self-regulating (what is termed homeostatic) steering mechanism. Using it, we can manage our language creation just as James Watt's flyball governor controls a steam engine. We can observe this cybertextual self-regulation in our mind's working memory as well as in the many language technologies -- manuscript, printed book, word-processor -- we have built to extend the very limited capacity of that working memory. Digital infrastructure offers, in some ways, a better cybertextual avatar for communication than supplied by our own mind."

> Can we someday say valid, simple, and important things about the working of the mind in producing written text and other things as well? (Pierce 62)

What is a Cybertext?

Most of us have heard of the word `cybertext,' used often as a synonym for "e-text" or "digital text," but needlessly so, because we have no other expression for texts viewed from the perspective of the "theory or study of communication and control in living organisms or machines" (1948), that is, cybernetics, as created by the American mathematician Norbert Wiener (1894-1964). The Greek root for `cybernetics,' *kubernetes*, has nothing to do with computing; it means "steersman." Cybernetics theorizes what controls or manages communications among life forms and machines. It applies to everything we utter in language, and Wiener rightly terms it "the theory of messages" (Wiener 1950: 106; Masani 251-52). Although Wiener did not say so, the messages of which he speaks in a cybernetic system are cybertexts. They come in pairs, the utterance-message and its feedback-response. Cybertexts pass through a channel from sender (speaker) to receiver (listener) through a medium awash with interfering noise. A cybernetic channel is an arena for two actions, messaging and feedback, as managed by five control modules (sender, channel, message, noise, and receiver). Although a mathematician, Wiener focused on defining the mechanics of cybernetics. Claude Shannon, who founded information science, created its physical equations. Admittedly, while cybernetics has stimulated many life and hard sciences in the past forty years, it has fallen into neglect inside science since the late 1960s (Horgan 207-08).

Once cybernetics stabilized, however, literary theory took notice. François Lyotard in *The Postmodern Condition* (1979) rather closely espoused Wiener's principles (despite overtly rejecting cybernetics) by adopting an "agonistic" model for communication and "a theory of games" (Galison 258). By 1985, Donna Haraway proposed her cyborg manifesto as a new strategy to combat sexism. Espen Aarseth first derived the word `cybertext' from cybernetics in the early 1990s. By 1997, in his stimulating book *Cybertext*, Aarseth applied the term to works that a reader must use physical force to read, like Michael Joyce's interactive fiction, *Afternoon* (in which the reader must click on hypertext links), or like the Taoist *Book of Changes*, that is, the *I Ching*, which asks the reader to cast stalks in order to select a page (a random act replacing an index or table of contents). Such texts, which Aarseth terms "ergodic" from its etymology, "path of energy or work," comprise a tiny, if innovative percentage of what we utter. Aarseth did not think that ordinary uttering -- writing, reading, and turning pages and moving one's eyes from page to page in a book -- uses force. Thus penning or reading Philip K. Dick's *The Man in the High Castle* (the only book I know that was written by consulting the *I Ching* at each step) does not count. Most Wienerian messages are not cybertexts in Aarseth's sense. He thinks of a cybertext as a *metaphorical* reading machine, not at all something in the world. Its interacting parts are the human operator-reader (Wiener's author-sender disappears), the material medium (page, screen), and words or language. The human reader is submerged into a figurative "machine for the production of variety of expression" (3). Unlike Aarseth, Wiener did not speak metaphorically. He believed that cybernetics applies equally to both life forms and air-missile defence systems. He never characterized the steering process in us as mindlessly machinic; the steersman in us remains human and responsible. Any communication, cybernetically speaking, is a Wienerian cybertext, whether the mewing of a hungry cat, a message left on a telephone-answering machine, or the bleep the computer makes when we try to save a file to an empty A-drive. Cybertextual messages include subvocalized speech (which is never actually uttered aloud), spoken language, text written on manuscripts, text printed on paper or computer screen, and anything uttered by a computer (such as much of the header to any e-mail message). All five control modules *work* here: the one uttering the text, the artificial channel constructed to hold it, the noise (which represents something's dissipated work), the receiver, and the message that prompts a feedback response. Work takes place universally in communication.

Two years after Aarseth valuably refocused attention on Wiener's cybernetics, Katherine N. Hayles made Wiener central in her *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (1999). Aarseth and Hayles believe that cybernetic research increasingly characterizes all communications as readings (that is, as what is received, not what is sent or authored). In her exposition of the three historical stages of cybernetics, Hayles locates the concept of autopoesis or self-organizing in the cybernetic research of Humberto Maturana. His experiments on the vision of frogs, over twenty years ago, imply that their "perceptual system does not so much register reality as *construct* it," a notion that led him to argue that "Everything said [in a cybernetic system] is said by an observer" (xxii, cited by Hayles 1999: 135). Obviously, this cybernetics lends comfort to reader-response theory and to deconstruction generally by dissolving both authorial intention and text objects. Wienerian messages, from this perspective, only exist insofar as they are assembled by a receiver. What distinguishes Aarseth's cybertexts from ordinary messages and so interests recent literary theory is that the "work" needed to read is shared by a human and an external device. A cyborgic reading machine emerges. Aarseth focuses on the part of that machine in the cybertext, and Hayles on its part in the cyborgic reader and virtual body.

Experimentation in cognitive psychology supports the contention that humans, as well as frogs, only hear what they actively construct. In a feedback loop, this very sentence is less received than created by a reader. For example, the so-called McGurk effect confirms, in a most interesting way, that we all unconsciously subvocalize a model of what we suspect someone else is saying. We then "hear" what we think we hear. Maturana might remark that the only one "saying" a message may indeed be its observer. A message generates feedback in us, and that feedback is initially, at least, that which we subvocalize in modelling. Philip Lieberman (57, citing McGurk and MacDonald 1976) describes this astonishing experiment:

> The effect is apparent when a subject views a motion picture or video of the face of a person saying the sound [ga] while listening to the sound [ba] synchronized to start when the lips of the speaker depicted open. The sound that the listener "hears" is neither [ba] or [ga]. The conflicting visually-conveyed labial place-of-articulation cue and the auditory velar place of articulation cue yield the percept of the intermediate alveolar [da]. The tape-recorded stimulus is immediately heard as a [ba] when the subject doesn't look at the visual display.

Listeners, using multiple senses, interpret speech by subvocal modelling and, on occasion, can accordingly be fooled into hearing a sound that has never been uttered. What the McGurk effect *definitely does not show,* however, is that we never hear what any speaker says. Naturally, a reader may not interpret my message in the way I "sent" it, because what Wiener calls noise constantly impinges on, damages, expunges, and corrupts a message during its transit. I may mis-speak, or some of my words may not be in your personal lexicon. Yet because we usually see the one who utters a message, using our eyes (it may even be a person standing before us, and here it is a physical or virtual image of a text), we have every reason to believe that an author exists! Readers see others doing exactly what they experience ourselves doing, when uttering or authoring a cybertext, and that very experience validates the reality of authorship in others. If literary theory redefines Wienerian cybernetic systems to exclude or at least ignore the sender-author, literary theory errs. It would be as easy to assert, against Maturana, that observers do not exist because they are all authors. One essential point eludes cybernetic research in the humanities today: there is little difference between an author and an observer. Cybernetics can be applied to what Wiener originally intended: the study of how all people communicate, not just how people use computers to do so. Wiener was right to believe that every utterance, no matter how produced, belongs to cybernetics.

This essay redefines the term and the concept of `cybertext' within Wiener's original broad theory of communication and proposes a new theory of texts, cybertextuality. Its principles describe how cybertexts are managed into being. Its scope covers the publishing, transmission, and reception of all utterances.

Principles of Cybertextuality

Cybertextuality encompasses the cognitive psychology of speaking, hearing, and reading. It subsumes the study of what happens to oral speech when we store it as writing. Cybertextuality includes the higher bibliography, the analysis of how any text is transmitted and transformed during print publication. If interested in how machine translation, computer poetics, or chatterbots like Joseph Weizenbaum's *Eliza* work, we want to study them cybertextually; that is, we want to get down into "language steerage" to discover what happens as they are communicated. Authorship attribution also belongs to cybertextuality: the author's distinctive stylistic features, or the author's idiolect, identify the message source.

What are the principles at work in cybertextuality? Three important ones are recursiveness, complexity, and homeostasis.

The first is unselfconscious recursiveness in speakers and listeners, writers and readers. Cybernetics has two actions, messaging and response or feedback. When a speaker utters a sentence, the listener -- in feedback -- models it cognitively and compares that construction with the received visual or the auditory data. Only the receiver experiences this feedback. Each human act of Wienerian feedback contains another miniature cybertextual cycle: the feedback produced by a listener-receiver to any heard or read utterance is (a) to model that message, (b) after comparing that model with the sense data, to utter it subvocally, and (c) to respond subvocally and then aloud to that utterance. If the listener verbally responds to the speaker, that message is tertiary feedback. Any overt reply responds to what the speaker himself models the received message to be about. The two-part message-feedback cybernetic cycle is not linear but, in human beings at least, recursive and spiraling.

This cycling takes place in any speaker-sender. You are not the only one who reads what I am writing now. I myself read and respond actively to what I believe I am reading. I form a model of what I experience, the sense data produced by what my eyes show when I look, and adjust that model according to that data. The author of an utterance is also its receiver. To speak of modelling one's own utterances may seem odd. Why do I need to model what I am creating and uttering? Again, cognitive psychology gives an explanation. When we utter, often we will only find out what we are going to say *when we say it.* Language occupies procedural memory (not semantic, episodic, or working memory) and only becomes self-conscious by the act of uttering. Reading from any manuscript or typescript also asks for modelling because, on paper or screen, there is no processing difference between our own writing and anyone else's. It is not the channel or medium, or the noise, that is what Marshall McLuhan termed *the message* or most important thing. The actions are, that is, those recursive message-and-feedback cycles that we engage with ourselves to shape what we utter.

Another principle of cybertextuality is its complexity. Embedded cycles are complicated. We appear to model cognitively at phonetic, lexical, grammatical, semantic, and discourse levels of language. During a conversation, a listener takes into account how the lips form a sound, how the speaker's face expresses affect, and how the body moves in gesture. Thus, in any conversation, we simultaneously manage several cybertextual message-feedback cycles. Even as I formulate my next sentence, I experience my first, just uttered sentence. Even as a listener is modelling and receiving my first sentence, he may be formulating his own response to it: that utterance is one which he too will subvocalize and then, if moved strongly to object or to agree, utter aloud to interrupt what I am saying. When cybertextual cycles overlap, each one is "noise" to the other. If my mind is too busy modelling an especially troublesome auditory sentence from someone else, I may be prevented from processing my response. The demands of multiple, overlapping messages for modelling and response compete for our attention. The subvocal "channel" in which we communicate with ourselves hums with embedded, simultaneous cybertextual cycles. We cannot attend to these sub-cycles. At cognitive levels, although we cannot consciously manage the cybertextual cycles that drive forward uttering, we are not Pavlovian creatures. Just because we are unconscious of how we are riding a bicycle (that learned behaviour too is enacted by our procedural memory) does not mean that someone else is steering.

A third principle of cybertextuality is homeostasis or self-regulation. The living and the mechanical behave cybernetically, that is, need feedback, because they cannot operate independently of their environment. Wiener writes that "To me, logic and learning and all mental activity… have been understandable only as a process by which man puts himself *en rapport* with his environment" (Wiener 1956: 324). Good lecturers routinely check how the audience is doing from time to time. A steam engine does not accelerate until its engine blows up. James Watt's flyball governor slows down the engine. Even so, communication works by a dynamic, stabilizing self-regulation named homeostasis. It normally dampens positive feedback, which accelerates a process beyond what is desired, with negative feedback, which brakes or reverses action. Mechanisms of control optimize communication to achieve stability (in machines) and clarity, accuracy, and pleasurableness (in human utterance). We control our texts by the effects that we discover they have, during communication, through feedback. What, then, are these mechanisms of control?

When I composed this paper, one way I had of keeping on topic was to shift often between roles, now sender-author, now receiver-reader. Devising this essay on a PC, I composed short sequences manually into digital storage by means of a keyboard, intermittently (I am a hunt-and-peck typist who looks down) checking the screen to see what I said. Those glances at the screen kept me on course. I paused, every few words, to self-regulate my progress. What had I actually uttered? I had to experience the uttered cybertext in order to manage it. Any essay consists of thousands of such small messages. During output, I subvocalized each passage into my mind and into computer storage simultaneously. I uttered a passage first in a stream of direct, linear mental experiences, one syllable after another, subvocally: I could "hear" the words as I typed them out and their flow was generally uninterrupted. My hands at the computer keyboard, *currente calamo*, received only positive feedback: nothing at all slowed the dynamic uttering. When I looked up to see the passage on screen, however, I paused for feedback from myself as a modeler-reader. At that point I was able to revise the passage. Each sequence went through a cybernetic cycling. Inner speech and manual typing gave positive feedback, but the visual review of the stored text gave negative feedback, managing the utterance. If I penned the text myself, my eyes would have always been on the page as I composed, and the average length of a passage in each cybernetic cycle would have been very short, no more than a word or phrase. In any event, a pause in my handwriting would normally have signalled the completion of a single cybernetic cycle.

The principal mechanism of cybertextual control, then, is *to internalize the cybernetic cycle.* Writers take ownership of it. They self-regulate by becoming their own reader. We manage composition first by dividing it into multiple, brief cybernetic cycles of message and feedback, and then by ensuring that we alone read each message. We find a means to stabilize each cybertext so that it can be held in our consciousness. Metaphorically, we transform Wiener's cybernetic channel into a torus or a möbius strip.

Where Homeostasis Takes Place: Working Memory

Cybertextuality explains how we trap utterances to control their making. What is the cognitive home of utterance management? It appears to be working (formerly known as short-term) memory. As David Olson long ago observed, the one essential tool that human beings use to govern their speech, even inner (silent) utterances, is working memory. It simultaneously stores visualized images of the text we are creating and offers us the cognitive space consciously to edit its auditorily-encoded words. As modelled by cognitive psychologist Alan Baddeley, working memory has an executive function that manages two "slave systems," a phonological loop and an audio-visual sketchpad. This loop, in all of us, holds no more than two seconds of speech, seven items, plus or minus two: i.e., George Miller's experimentally established limit (cf. Pierce 248-49). Text in the phonological loop enters and exits irresistibly and dynamically. If we want to focus for longer than two seconds on a short sequence of words, we must recycle it through the loop by means of the executive function. The phonological loop of working memory gives us the first mechanism to trap the utterances we ourselves make. The audio-visual sketchpad is the second mechanism. It can store, as an image, a much larger amount of text if perceived visually.

Although we do not know exactly how these two functions collaborate, it may be that we use visual working memory to suspend the text, and the phonological loop to edit it piecemeal. Some support for that is found in two facts. First, the human brain's language functions are innately auditory: the semantic processing associated with Wernicke's area, and the syntactic processing associated with Broca's area, cannot handle visual data (words as "seen"). The brain always re-encodes the language which we receive visually into auditory form before working with it. Second, the ancient *loci et images* method of artificial memory succeeds by associating spoken words with an imagined and visualized space (a forum, a room, a landscape) that has symbolic objects located at different places in it (Yates 1966).

Cybertextual control, centered in working memory, operates under many constraints. It relies on unselfconscious mental processes to generate its own utterances and to model and deposit external utterances received from the ears and eyes. A capacity of two seconds of generated or received auditory text constrains it most. It of course uses retention in long-term memory to deposit and withdraw texts to revise them consciously for uttering aloud, on paper, and onto a screen, or for being cycled and recycled for planting in revised form back in long-term memory. Yet mnemonics is a weak cybertextual tool. We can only probe long-term memory blindly, and we remain foggy about the mechanics of how it retains things. Every human cybertextual technology addresses this lack of permanent working space.

The Blueprint for Communication Technologies

It is said, "With a theory and a nail, you've got a nail." How does cybertextuality help us understand practical things like writing, reading, and the technologies of language? I argue here that no matter what kind of thing does the uttering (a human being or a machine), and no matter what kind of cybertext they utter (inner or vocalized speech, writing on papyrus, on paper, or to the computer screen), the utterance is always governed by cybernetic cycles in which the author becomes the reader who provides mainly negative feedback to himself as author, and the cybernetic channel becomes a torus. Now I will argue something more relevant to history: that the facility in which the cycled texts are edited is invariably modelled on human working memory. All language technologies, whether the medieval manuscript scriptorium, the Renaissance printing house, word-processing software and hardware, and even artificial intelligence, are literally McLuhanesque "extensions of man." They build on working memory and radically enhance it to help us wield cybernetic control over our texts.

Consider writing as a technology. In whatever form, writing visualizes a text, as the audio-visual sketchpad in working memory does. Eyesight replaces in-sight. However, writing does so without the dynamic limitations of working memory. We do not need to concentrate to keep the image alive in the mind but can avert our inner and outer gaze for as long as we want and still recover the text, by means of direct sensual experience, in order to adjust it. Although we must still use working memory to alter a text (because uttering itself remains a largely opaque cognitive process), we no longer need fear losing that text. We cannot be distracted when recycling it through our phonological loop. By eyeing the text, at any time, we re-encode it in auditory form in working memory. One text can be uttered over a very long period of time, with many cognitively inactive periods. Word-processing software also enhances working memory by allowing us to retain, not only the approved text, but all the versions through which it has passed. In working memory, naturally, these stages would be wiped out when the revised text was dynamically recycled through the phonological loop.

Once we understand how we "steer" our utterances into being cybertextually, through working memory or a simulacrum of it, we can explain anomalies in our communications technology. If we can only cognitively process language in auditory form, why do we print out our texts on paper to proofread them? Why don't we listen to them? Although most workstations have speakers, we do not broadcast texts to ourselves, and we do not listen to our texts when editing them unless we are blind. Limitations of the phonological loop in our working memory must account for how we design computer writing systems. First, if we "printed" to vocal speech, we could never examine the text as a whole. We could only listen to a clause at a time because if we output more than that, as speech, the first clause would be dynamically "written over" in working memory by the next clause. It appears that cybertextual feedback, what the author as reader remits to himself, must be visual. Second, why do word-processing systems not echo back to us the words we type in, one at a time, at input speed? Cybertextually, would not immediate auditory feedback reach the language areas most quickly? Yes, it would, but the "articulatory suppression" effect interferes. It occurs when someone cannot subvocalize a piece of language within working memory because he must repeat aloud, again and again, a single sound. Auditory speech captures our listening mind and thus even the sound of our own words, as we utter them, breaks the internal cybertextual feedback cycles we rely on to stabilize composing. Hearing what we had just typed in would distract us from typing more.

Working memory, as its name suggests, is more than short-term storage. We appear to edit small pieces of our utterances "there." Yet "there" is not localized to one area of the brain; and the cognitive business we see in working memory takes place outside selfconsciousness. The cybertextual language industries, for that reason, build computer technologies today that not only increase the size and the durability of language storage, now measured in terabytes, but also simulate simple mental operations on sentences that we are aware of "taking place" in working memory. This happens both in writing and reading.

Spell- and grammar checkers, outliners, and searchable thesauri make explicit *what we know* of composition rules (in Broca's area) and semantic clustering (in Wernicke's area) so that our minds can invent expressions and can make decisions, more easily, during writing. Some simple working operations that follow from a cognitive decision (such as changing the number of a verb, or turning passives into actives) can be done manually. So far, our attempts to simulate language generation -- the cognitive power fills working memory with language and alters the sentences it holds -- have not been effective. Expert systems can handle symbolic logic but not story-making. No way has been found of duplicating the "I" in human consciousness that makes a story. Computer-poetry generators simply fill in the slots in sentence patterns from word-lists by random selection. Chatterbots use this and other heuristics to simulate a conversational partner. The "working memory" externalized in these toy systems does not have the language facility that our brains store in procedural memory. If we knew how that worked, we might do a better job at duplicating it. Technologically, we can extend mental storage but not replicate mental activities of which we become superficially aware in working memory.

We also build software that can externalize working memory for listening and reading, that is, for people as receivers. To teach children to read, we can make a computer output, not just printed text, but a voice that “reads” it aloud (a voice such as that we are conscious of in silent inner speech). This gives direct access to the mind’s language areas. We perhaps eliminate “noise” that interferes with the mind’s reception of natural language. A computer screen can also simultaneously project both words and pictures of what these words mean in the teaching of basic literacy: an literalization of the *loci et images* method of artificial memory. Machine-translation software enables us to read texts in languages other than our own. So-called “close reading” skills taught in literature courses locate non-linear thought structures in texts. Interactive concordancers and text-analysis systems can highlight these stylistic and content patterns of a text. For example, by using frequency-based collocational information, we can identify and map semantic clusters onto an electronic text. Yet the database systems and hypertexts which make explicit such associative relationships of things held in the implicit, deteriorating networks of our brains’ long-term memory only extend innovations that enabled manuscript technology to improve on papyrus (cf. O’Donnell). These techniques, although statistically based, are related to simple indexing, something that a machine does well, but a mind not well at all. Readers are often astonished by textual patterns. They reflect the thinking that the author did when preparing to compose, thinking that could not be explicitly expressed in linear form as sentences. In a few very limited ways, a computer’s “working memory” can “read” or “receive” much more capaciously than we can.

Language Technologies: Noise and Noise-proofing

By building artificial working-memory systems for composing and understanding language, we complicate the root two-stage cognitive cybertextual cycle. This cycle begins when, mysteriously, the mind generates an utterance, or finds one in external sense experience, that is then immediately received in working memory as a silent inner voice. What we call listening or reading resembles composing. The only difference is the source of what falls into working memory. Listened speech enters directly from our auditory system. Read speech enters visually and, after recoding in auditory form, also enters directly into working memory. Before that utterance moves around the phonological loop, the mind has already modelled it. We are aware of this modelling as intuitive understanding of the gist of something, and this *understanding* is what the mind feeds back to itself by placing an utterance in working memory. We are not aware of how our mind generates language. We appear to model and understand our own utterances initially as if they were the speech of someone else.

By externalizing our working-memory onto paper or screen, we model and give feedback on not only our inner voice, which falls into working memory, but also visual text, remediated speech. We manage or steer composition composed silently and then written on the page, or to a computer file and screen, by means of two almost overlapping cybertextual cycles. The cybernetic channel, metaphorically, resembles a *twinned* torus. Our mind must model two received cybertexts: the inner voice (received instantly), and its re-mediation as visual input through the eyes (received after cognitive recoding into auditory form). We use both slave systems of working memory at once. Cognitively, our receiving attention is divided. The more functions that an external working-memory system has, the greater the possibility of conflict between the models that the mind makes. For example, if we empower our word-processor to highlight passive moods or repeated phrases as undesirable, the word-processor and our own hidden language-maker -- which uses redundancy to combat noise -- conflict with one another. We receive two competing models of a text for possible approval. The artificial working-memory systems in information technologies themselves create noise.

Cybertextually, this conflict raises the question of how positive and negative feedback differ. We might conceptualize positive feedback as urging us during uttering with the cry, "Good boy! more of the same, now … press on!" and negative feedback as warning, "Hold it, now… delete or rephrase this phrase, slow down, keep on track!" Our auditory uttering process adds redundancy to text as it speeds along, but as we visualize the emerging utterance we apply conflicting stylistic heuristics. The struggle between positive and negative feedback makes for noise.

Should we conceive negative feedback, what we need to self-regulate good text, as a neurological Strunk and White? Because negative feedback in composing and listening or reading changes as cybertextual technology does, feedback today resembles Strunk and White (be economical, use concrete language, construct active sentences, etc.) *because* of the growth of external working-memory systems. They can now store any amount of text; and so we can utter as much as we want. Their thesauri enable us to sprinkle our own vocabulary with unfamiliar words and phrases from other languages and registers; and so we can make opaque sentences. These technologies enable us to think of our composing self as a multiple personality, the many instead of the one (for example, we think of ourselves as collaborating with a machine, or with others whose writings have been externally stored), and so we use the passive mood. Insofar as any language is a historical social construction over time, negative feedback also changes over time.

Let me translate this conflict into cybernetic terms: negative feedback regulates language by adjusting the ratio of information richness and potential loss of information to noise. Information science measures information quantity in bits; the measure itself is termed "entropy" (Pierce 80). Where we have no way of storing an utterance (as when we talk aloud), we sacrifice variety (that is, information) to repetition. English itself has redundancy built in; that explains why we can understand the partly noise-lost expression, "Hell* how *** you ***day?" Early orally-uttered poems like *Beowulf* employ oral formulas and patterned alliteration, types of semantic and stylistic repetition that help a listener to recover when some interference occurs. Negative feedback in a pre-literate society insists on such redundancies. Once we developed writing systems, negative feedback changed systemically according to cybertextual principles. Compositions could increase in both length and richness of information because we could store the text externally, but visual milestones like punctuation, capitalization, and paragraphing became necessary. Scribes were not for long allowed to record poems like *Beowulf* as a stream of words that lacked pointing and soft hyphens (joining words that were not meant to be split) and did not begin a new line at the end of a verse. Later, William Shakespeare no longer had as much use for redundant formulaic expressions. Neologisms, unusual collocations, aphorisms never before encountered, and other innovations came to mark cybertexts by him and his contemporaries. Four centuries later, when people employ computers as their own external working-memory systems and do not have to rely on printing houses to store and publish their texts, compositions become increasingly shapeless. Anyone obliged to write something might patch together unrelated pieces of texts from several authors as if it was an integrated thing. Historically, to ensure effective communication, negative feedback must change. Software was written to identify wordy constructions (such as trains of noun-phrases or prepositional phrases) and plagiarized passages. Cybertextual principles use software to regulate the flow and character of text. Although repetition is now less essential (after all, the text did not disappear after uttering, and huge print-runs or long-life Web sites ensure that noise cannot permanently damage what is composed), economy and the other Strunk-and-White virtues migrated from expository textbooks to online, working style-checkers. Society establishes negative, self-regulatory feedback, but cybertextual technology -- specifically the prevailing working-memory systems we must rely on -- determines the conditions under which society defines that feedback.

Cybertextuality and the Digital Humanities

Researchers owe much to Norbert Wiener because his cybernetics offers a theory for comprehending cognitive or inner speech alongside speech, writing, and digital texts. Cybertextuality explains digital technologies as tools that regulate our utterances by externalizing working memory as a locus for the recursive cybernetic cycle. Why do we create e-libraries if not to magnify the life-span and the size of texts? Why do we encode texts if not to overdetermine what they have to say? Encoding makes explicit certain features of a cybertext (e.g., an SGML tag characterizes or names a passage) and creates additional redundancy in it (e.g., a tag repeats the information in a carriage-return/linefeed). That is, encoding externalizes those aspects of long-term memory of which we have a glimpse in working memory. We make text-software to improve the reliability of human authoring and reading. Cybertextuality also explains why we simulate human senders and receivers in machinic form. Digital avatars externalize aspects of our cognitivity. By experimenting with interactive fictions, computer games, chatterbot dialogues, and digital poetry, we are building machinic senders, cybernetic machines, with some human powers of content organization but with different vulnerabilities than our own. Digital infrastructure itself can be interpreted cybertextually as a collective effort to make a better cybernetic avatar for communication.

More generally, cybertextuality charts how creativity and technology interact from pre-historic times. It humanizes cybernetics by applying it to composition, listening, and reading. Cybertextuality gives readers a systematic basis for understanding any text insofar as it is managed into being. *Beowulf*, which once existed only in the performative moment of its bard's cognition, late in the Old English period was externally stored on vellum. Communicated orally at first, not for reading, this poem changed when read in manuscript, or in modern editions, because then it is re-uttered and remodelled by scribe and editor. We have perhaps superimposed other texts over the performative palimpsest. T. S. Eliot's *The Waste Land* or James Joyce's *Ulysses* can be read as purely cognitive texts too -- the mind talking to itself -- but it would be historically misleading to do so. They were managed into being cybertextually by an artificial working-memory system, the typewriter, that extended their authors' cognitive powers. No human being, unassisted, could have "uttered" them. Pen, typewriter, and word-processor convert auditory language to visual language, ephemeral utterance to stored text, and somewhat formulaic phrase-assemblages to complex periodical sentences that can include text composed by others (cf. Chaytor, Ong, and Clanchy). In a like manner, machinic agents, hypertext software, and Shelley Jackson collaborate in steering -- using a mass of sub-messages, each generating multiple feedback loops -- her interactive fiction *The Patchwork Girl* across an electronic channel to the reader. Its author-sender is cyborgic. Something of human agency has slipped the confines of the mind and lodged itself in a device to which an author has wedded herself. Catherine Hayles terms this reflexivity: the power of machines to affect their users, as by entangling writers (and readers) of text within their feedback loops. For example, insofar as e-mail partly replaces the telephone for brief exchanges, people now write messages that are easiest for the technology to process: brief and encoded ones.

Cybertextuality allows us to ask interesting questions about the oldest known literary works as well as new experiments in e-genres. Thinkers as diverse as Marshall McLuhan, Joseph Weizenbaum, Walter Ong, Steven Pinker, and Jerome McGann have a place there. Should cybernetics seem outdated -- it is not the subject of much research today in the sciences -- remember that it is older than most literary theories. It has also been the butt of jokes, none better than by Douglas Adams in *Hitchhiker's Guide to the Galaxy* (1979). Adams' Sirius Cybernetics Corporation, whose marketing division defines a robot as "Your Plastic Pal Who's Fun to Be With," built serious Marvin, the paranoid android. Marvin complains of a lack of feedback from Arthur Dent, Ford Prefect, and the rest of Adams' gang because they stand it up and leave it waiting, intensely bored, for million-year periods. Deep Thought, another cybertextual machine in the novel, keeps humanity waiting millions of years for an answer about the meaning of the life, the universe, and everything. Where we would least expect, literature depicts us cybernetically stalled in mid-cycle, or snared in recursive self-revision, or isolated on the threshold of a cacophonous channel.

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