De Crypticis Methodi or willywoNKA meet$ the^ terMIN@tor :: Codework, Information, Poetics / _draft 11/28/2005_

Sandy Baldwin, West Virginia University, charles.baldwin@mail.wvu.edu

> Form is a trace of the formless.
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> – Plotinus
>
> $H = \sum p_i \log p_i$
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> – Claude E. Shannon

The cryptographic principles for "handling and filing" of plain text, that is, for "the original, literal texts of messages sent in secret or confidential code," are serious and strict. In his lectures training Signal Intelligence Service and National Security Agency cryptographers, William F. Friedman stated: "There should be in existence only a definite, limited number of copies of the plain text of the message cryptographed in any secret code or cipher and these copies should be carefully controlled in distribution, handling, and filing. […] The plain text should never be filed with the cryptogram itself. The further the containers in which the plain-text copies are kept from those in which the cryptograms are kept the better. These containers should never be kept in the same safe. If only one safe is available, it should be used for the plain-text versions, keeping the cryptograms in a locked filling cabinet."[1] Also: "Plain text and its equivalent code or cipher text must never appear on the same sheet of paper for final copy or for filing purposes. Work sheets should be destroyed by burning."[2] What interests me here is the maintenance required to isolate the literal and its encryption, a distance that supports technical layers, cultural institutions, but also military logistics and rules of engagement. The force that binds and separates plain text and its encryption requires a ritual burning should they be brought together. The conflagration built into these texts supports and is supported by law and by ideologies of identity and security.

Under today's conditions of "Pretty Good Privacy" – where the NSA no doubt intercepts all our communications down to the merest post-it note, but probably can not be bothered to read the critical mass of data beyond flagging key words such as "turban" and "peace" using data sniffing protocols such as Echelon – under such digital encryption standards, every byte of data – and this means every pixel and every screen of every computer everywhere, that is, every byte and its monitored output – figures in the open secrecy of plain text and encryption. It is as if plain text were the secret core of information. It is as if a total decryption would produce a textual superset of all possible knowledge. Plain text is the fantasia of the library and the cryptoanalysis of text is a model of the depositing and retrieval of knowledge in archives. Of course, the crucial thing is this "as if" which metaphorically repeats the notion of the archive without clarifying it. There is no plain text but only systems of encryption and decryption, institutions of secrecy and revelation. Information is always totally secret and totally open, and this is my topic. Further, I will illuminate the material and mnemotechnological crypt in the concept of information, overlooked and misunderstood by the influential recent posthuman and new medial arguments about information theory.

Friedman – director of SIS cryptoanalysis, technical advisor at the NSA from its founding by an 1952 executive order that was itself immediately classified to hide the fact of the agency's existence; also, the inventor of the M-134 precursor to the military's ECM Mark

II or SIGABA, a multi-rotor proto-computer encryption device with pseudo-random operation – wrote the book on American military cryptography. But all this was a warm up. In 1955 he retired, with a hefty hush money payoff from the government, and focused his cryptoanalytic skills on the authorship of the Shakespearian plays. In fact, he and his wife Elizabeth were "Baconians" since before the First World War, and now with techniques developed by and for the NSA – then and now the largest employer of Ph.D.'s and computer programmers in the world – they set to work on Shakespeare. Their book *The Shakespeare Ciphers Examined* appeared in 1957 and won the Folger Shakespeare Society Award. Despite this honor, the book failed as a final decryption of Shakespeare. Unfortunately for the Friedmans, the cryptoanalytic science called "the most potent secret weapon of World War II" fell short when it came to literature.[3] The problem was the uncoded materiality of literary texts. No cipher could be definitively shown in Shakespeare's work, though no end of decipherment was possible. The length and complexity of the material exceeded the limits of rigorous, final decryption, leaving only partial decodings, that is, leaving literary criticism. The sheer literalness of plain text gave away no secrets.

Meanwhile, from April to October 1960, Jackson Mac Low composed *Stanzas for Iris Lezak*, in part while riding the subway between the Bronx and Manhattan. The poet's early works were expressive and surreal, but by the 1950's he was composing using chance operations – flipping coins, throwing the *I Ching*, and so on. In "Stanzas for Iris Lezak" he first adopted the "chance acrostic" method that characterizes much of his work up until his death in 2004. Mac Low selected an "index sentence" and then spelled out each poem acrostically from the index sentence, using words found by pre-determined operations. These operations varied from poem to poem, but typically involved selecting a book or magazine, and then reading until encountering a word beginning with the first letter of the index sentence. This provided the first word of the poem. Mac Low then read on until he encountered a word beginning with the second letter of the index sentence, providing the second word of the poem. The process continued iteratively using the index sentence to generate the poem from the source text. Index sentences were chosen on impulse and embedded personal choice in procedural text generation. The first six poems in *Stanzas for Iris Lezak* – "6 Gitanjali for Iris" – use what Mac Low called an "exultant" index sentence, a macho dedication to the poet's girlfriend: "My girl's the greatest fuck in town. I love to fuck my girl."[4] Subsequent poems generate the index sentence from the source text itself, using the title of the text, the first sentence, or some other text string. Poetry no longer floats like Wordsworth's cloud or offers many ways of looking at Stevens' blackbird. Instead, poems are found like the following, from *The American Heritage Word Frequency Book*, a source for many of Mac Low's works, at frequencies between 1.0623 and 1.0611 for U (word frequency per million): "fortnight hues weaknesses scaled cilia heaven's soberly closeness nobody's laughing lessened Vincent."[5]

Of course, Mac Low used exactly the method Claude Shannon used to represent the probability structure of an information source in 1948's *Mathematical Theory of Communication*. "Pattern Recognition by Machine" – one of Mac Low's first chance acrostic pieces, which begins "*Perceive*. *As Letters*. Think? Think? Elusive, relations, now met most of the classic criteria of intelligence that skeptics have proposed." – works through a 1960 *Scientific American* article on information theory.[6] Aleatory content cites a cultural milieu of circulating discourse on the informatic structure of language. Admittedly, the pattern and resulting meaning of the poem are procedural outputs. The procedure empties the citation and proves the point of the citation in doing so. And, of course, Shannon's work was precisely enabled by Friedman's cryptography. Friedman's 1920 "Index of Coincidence and its Applications in Cryptography" was the first attempt ever to formalize the statistical regularities of letter and digraph or letter pairings in English. An itinerant knowledge of frequencies existed in cryptographic texts from the first, with Lavinde's famous *Trattati di Cifra* of 1480 containing one of the earliest letter frequency tables. This knowledge was materialized in the famous sequences of lead slugs "etaoin shrdlu cmfgyp wbvkxj qz." The sheer repetition of these letters left them in linotype boxes until Friedman connected frequency to the structure of the language. In doing so, he dissolved the lead slugs into one aspect of a schema of mathematical frequencies. Friedman showed that any two consecutive characters selected from a plain text would be the same character 7% of the time on the average, due to the common nature of digraphs such as "ee" or "oo" or "tt," whereas in purely random text the same character would only occur twice 4% of the time on the average. Unlike a randomly generated string of characters, a message will possess frequencies that persist as traces in even the most complex encryption.

The 3% difference between 4% and 7% made all the difference: just this was sufficient to render cryptographically insecure any key generated from a handy book, the traditional source for random keys. Shannon's information theory provides a mathematical explanation of this "index of coincidence." As a result, every information source is modeled on cryptography. At the same time, Shannon, by necessity, exemplifies information using language. His elaboration of how a probabilistic selection of English language characters "approaches a language" is not simply an example of informational probability but the exemplary instance that models all others. The probabilistic structure of any information source will resemble and deviate from this model. Shannon constructs "typical sequences in the approximations to English," ranging from "zero-order," a string of "symbols independent and equiprobable" – which reads something like this: XFOML RXKHRJFFJUJ ALPWXFWJXYJ FFJEYVJCQSGHYD QPAAMKBZAACIBZLKJQD – to "second-order word approximation," where "word transition probabilities are correct," that is, where the likelihood of one word following the other reflects the structure of the language, but where "no further structure is included." The example reads: THE HEAD AND IN FRONTAL ATTACK ON AN ENGLISH WRITER THAT THE CHARACTER OF THIS POINT IS THEREFORE ANOTHER METHOD FOR THE LETTERS THAT THE TIME OF WHO EVER TOLD THE PROBLEM FOR AN UNEXPECTED.[7]

Shannon insists that ATTACK ON AN ENGLISH WRITER THAT THE CHARACTER OF THIS "is not at all unreasonable."[8] What is reasonable about it? It is as if the "frontal attack" were a violent thematization of the disjunction of information and meaning. Shannon does not comment. Of course, the string is nonsense but it is given as an example, the only example, of "second order word approximation." The string is an example of the literalness of information and voids any apparent meaning in making this example. Information means the production of this string. Shannon adds that in the sequence of examples, the "resemblance to ordinary English text increases quite noticeably."[9] What is resemblance here? The heuristics of resemblance are the background aesthetic, the necessary opening on which networks of meaning are built. The presupposition of an aesthetics of resemblance is built on the positional force of rhetorical circuitry, the material turn of words where program and reading meet. "Not at all unreasonable" means sufficient for worldwide discourse networks of open secrecy.

Shannon's method was to compose streams of characters with a book of random numbers, in conjunction with a table of letter frequencies. Word order approximations, that is, where the information source represented contains complete words in the English language, become exponentially more difficult and Shannon turned to an easier method: he selected a book off the shelf, opened it at random and selected a word. He shut the book, re-opened it and selected another word for the next in the example, and so on. For second-order approximation he selected a word and the word next to it. Word to word transition in printed text was an adequate representation of the statistical structure of the entire language. Moreover, the corpus of printed texts represents the superset for statistical analysis of the language, as word frequency books show – the American Heritage 1969 version is a "computer assembled selection of 5,088,721 words (*tokens*) drawn in 500-word samples from 1,045 published materials (*texts*) […] selected from 6,162 different titles."[10] Mac Low adopts the same techniques and names the results poetry, foregrounding the surplus at work in the theory of probabilistic information sources. What Shannon's theory, as exemplification or model, names as given in every information source – truly a gift, a poetic gift – is precisely this surplus.

I should add that the current vogue for "codework" literature reflects an awareness of this gift. Even without following the links from Mac Low's Fluxus-associations to the contemporary codework and net.art scene, it is clear that the famous jodi.org does nothing more than present the crux of information, in a repetitive but always striking way, reminding us that what we see is not what we get, and forcing the experience of negotiations between seeing and getting. As I argue elsewhere, it is not necessary for the code to "work," at least in the strict sense described by the institutions of computer science and machine construction, i.e. not necessary for the code to be compilable and executable on a standard microprocessor running an OS that produces a finite output.[11]

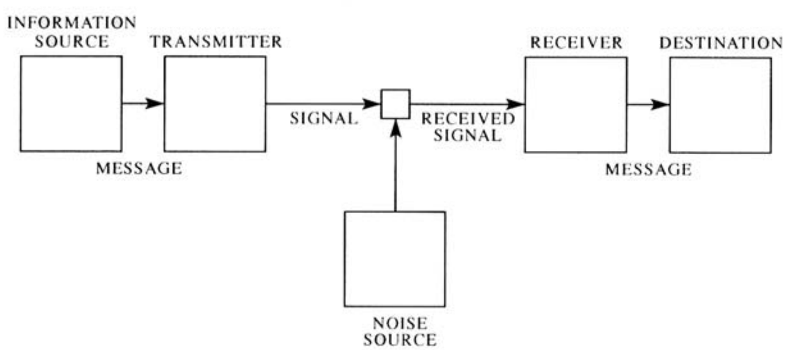

Figure 1[12]

Shannon's information theory is suspended between the cryptographic logistics of granulated linguistic symbols and a surplus poetics of chance expression. His "schematic diagram of a general communication system" is well known [Figure 1]. The diagram is in some way "harder" than any given information circuit, as Wittgenstein said of schematic diagrams *qua* actual machines. Each box in the circuit is the same, a black line and an empty space, and the repetition enforces the transportability of information. Transmitter and receiver are visibly the same, assurance that what passes between will be the same. And because we can take in the diagram in a single glance and find that its parts are equal and connected, the implication is of some information transmission at work prior to any message. The diagram is already in existence, guaranteeing the eventual communicational success of any information circuit, rendering a jam in the system simply the need of better implementation of the diagram and its functions.

Also familiar is Shannon's assertion that "semantic aspects of communication are irrelevant to the engineering problem,"[13] key evidence for his guilt in formulating information as "a kind of bodiless fluid that could flow between different substrates without loss of meaning or form," according to Kate Hayles' influential *How We Became Posthuman*.[14] Hayles is well-intentioned but imposes sanctions on continued discussion of Shannon's work by predetermining its interpretation. It turns out that Hayles' devastating critique bears little resemblance to Shannon's actual argument. The now-canonized notion that Shannon "defined information as a probability function with no dimensions, no materiality, and no necessary connection with meaning" needs to be re-examined.[15]

First point. Lamenting information's lack of a "necessary connection to meaning" implies a positivist and representational framework, and thus a hermeneutic commitment to a universal and direct experience, to a communication that we all share and comprehend within the closure of semantic logic. The discourse of semantics is built on sign relations of intentionality and reference, with logic the reductive background guarantor of meaning. The resulting "ideal speech situation" assumes information theory as already a working product. There must already be communication for communication to occur.

Hayles, with Mark Hansen and others following her lead, announces a preference for "semantic information," Donald Mackay's corrective to Shannon's theory, though already mentioned in Warren Weaver's introduction to Shannon's original text.[16] I grant that Mackay is closer to the source of the problem than Hayles, since he sets out to measure the meaning of information precisely from the recognition of the impossible disjunction of information and meaning. Semantic information measures the mediation of meaning by this disjunction. Information's inevitable and unsurprising reflexivity and the resultant difficulty in computing informational effects are taken as signs of the interest of Mackay's theory. Mackay seeks to grasp the complexity of representing information by distinguishing between "structural" and "semantic." This powerful differentiation produces a structure that seems to resolve the engineering problem and return semantics to information. Structure is reflected in meaning.

Mackay then argues that represented information is not information but is mediated by information, and this mediation is itself represented by the relation between representation and structure. Mackay describes stumbling across this insight in 1945, while at King's College in London. He adds that the stumble was less accident or intuition than reading of Wittgenstein's 1920 *Tractatus Logico-Philosophicus*.[17] Mackay acknowledges Wittgenstein's repudiation of the atomistic approach, but is convinced that information is where the formalism of what cannot be "said" but only "shown," will be shown and quantified and not remain "mystical," as Wittgenstein was forced to conclude and as the materiality of Shannon's theory asserts. Confident that the relation between representation and means of representation will measure information, Mackay writes: "A measurement could be thought of as a process in which elementary physical events, each of some prescribed minimal significance, are grouped into conceptually distinguishable categories so as to delineate a certain form (for example, the image on a photographic plate or the wave form on an oscilloscope) with a given degree of precision."[18] The goal is this *form* readable through the conceptual framework. Mackay's examples are significant: the photographic plate and oscilloscope wave are paradigms of frozen light and sound. As examples, their force is readable far beyond their exemplification of simply measuring an image or sound. Rather, the moment of freezing is carried on in the momentum of theoretical reflection. Both are images of the mediation of images by withdrawn and invisible mediality: we see the image (light) on the photographic plate in and through the (image-making) light. The resulting "abstract representation" is precisely correlated to the medium it captures. Its abstraction and its abstractability, insofar as we gaze on the representation to reflect on the medium, is proof of the delivering up of the form involved (or the "weight of evidence" in Mackay's terms).[19]

But the fact that these images capture the "form" of the medium invokes a much older, pre-semantic understanding of information, not at all the fine webs of meaning hoped for by Hayles and Hansen. Mackay's preferred metaphor of informational selection as drawing on a "filing cabinet" of available representations already presumes that representation comes with a certain amount of abstraction: not simple quanta – no Wittgensteinian atoms here! – but the mnemotechnic placing and ordering, filing and retrieval, of the selection set.[20] It is not that there are structural criteria for information and resulting quanta of information, but rather that there is information that leaves a readable form in the differentiation between structure and quanta. Shannon's insistence on the absoluteness of the "engineering problem" is displaced by Mackay's assumption that *structure gives us more*.

The open question is what advantage is gained by the heightened description. Mackay's convenient method of adding structural criteria and resulting quanta in a kind of tallying, leads to claims to measure meaning at the receiver, that is, in humans. Mackay explicitly presents this as a "search for basic symbols" or coming to terms with information, where communication means "replicating representations."[21] The presumption is to name the images in my mind as frozen moments like photographs or sound waves. No doubt we must come to terms with a world of information, but Mackay's arguments remain more interesting for the hopes they promulgated than their results – which Hayles and Hansen are forced to admit were meager at best – hopes generated and fostered by the self-reflection of structure and representation. That this meta-coding is information as "unarticulated self-reference," to use Niklas Luhmann's formulation, seems to trouble no one. Perhaps this makes perfect sense: having established a fungible reserve of reflexive semantics, the thematization of information and its effects requires little effort. Such thematizations, however, remain intrasystemic re-descriptions, re-situating information theory within the logic of semantics without first establishing that information is semantic or that information has any necessary connection to meaning *as* semantics. While Hayles' preference for "embodiment" would seem to vitiate the turn to semantics, she chooses instead to offer accounts of embodiment that remain within the referential and intentional – a thematics of embodiment. Other similar attempts at semantics of embodiment, such as "metaphors we live by," equally continue to invoke a pre-semantic lifeworld as theoretical ground.

Semantic information is part of a fascination with outcomes and results, part of the logic of the perlocutionary effects of information – exactly what information "does," as Hayles says of Mackay.[22] I am more interested in what remains absorbed, hidden, but still functioning within information – the blind spot that enables the coding and interpretation of semantics, and the thematization of embodiment, materiality and the rest, that is: the "illocutionary" potential as what information "is." Here I follow the Hans Ulrich Gumbrecht's argument for moving from "interpretation as identification of given meaning-structures to the reconstruction of those processes through which structures of articulated meaning can at all emerge."[23]

The emphasis on information's lack of meaning illuminates the after-effect of information received, the backprojection of the semantic dividends onto the enabling structure. Without a doubt, Shannon's arguments, diagrams, and formulas radically exclude meaning. This is their poetic and mythic quality. His insistence on this exclusion seems a kind of delusion, a belief in the immediacy of information beyond cultural semiotechnics. I want to defend this delusion, against all odds. The "engineering problem" is somehow harder and more absolute than any of the recommended solutions. Shannon's delusive insistence exposes the aesthetic ideology at work in the concept of information, a mythic decoding and reading that we name context, meaning, or materiality, and which his critics side-step but leave it in place as a background assumption. My concern is neither to endorse nor refuse our investment in this ideology, but to expose it.

Second point. I fail to grasp how Shannon's theory defines information "as an entity distinct from the substrates carrying it," lacking dimensions or materiality, as Hayles has it. Shannon offers nothing if not a theory of the radical, critical materiality of information. Shannon defines information as a measure of the improbability of a given message in relation to the overall probabilistic structure of the information channel. The more unlikely a message, the more information it carries. This is a definition premised on the materiality of information. In practice, information is measured against its inverse, redundancy, that is, the regularity and predictability of the information channel, exactly what allows coding and decoding, compression and efficient transmission. Shannon's experiments in producing redundancy generated itinerant codework poetry. He created nonsense sentences with multiple procedures, using random numbers, arbitrarily typed characters, and cryptographic techniques. In a series of guessing games, he and others would guess the text of a book, producing a reduced code version of misses and hits. Redundancy is the skeleton key to information theory as a pragmatics of transmission. In the redundancy of the message received, we experience the mediality of the information conveyed. Viewed as a general system of encoding and transmission, information theory is no doubt abstract, but Shannon is precisely concerned with the singularity of particular messages. Transmitting a message requires redundancy. The hypothetical limit case of "pure information," a message without redundancy, is un-transmittable. Pure information, information as such, far from being abstract and disembodied is singular and material.

By 1951, Shannon was estimating redundancy in the English language as high as 75%, if time sequences are taken into account. This is an astonishing number: 75% of language is blablabla. Shannon arrived at an extraordinary method of guessing the redundancy of English based on implicit knowledge of statistical structures of language at the word level. The famous guessing game asks subjects to guess selected passages of a prose text pulled off the shelf, letter by letter. The resulting measurements indicate the redundancy of printed English, but equally indicate the *material* redundancy of knowledge implicit in the guessing subject. The game works as follows: the subject guess the first letter of the prose passage. The answer is supplied if the guess is incorrect, and the game continues. The subject slowly writes a "reduced" version of the text. This coded version approximates the printed text as guesses improve over time, since larger strings of the text are available to frame each subsequent guess.

Shannon supplies sample guesses. In the following, the first line is the prose text and the second the reduced text, where a dash indicates a correct guess and the correct letter is written in where mistakes were made. That is, mistakes are not indicated by recording the mistaken guess but by the repetition of the correct letter.

(1) THE ROOM WAS NOT VERY LIGHT A SMALL OBLONG
(2) ----ROO------NOT-V-----I------SM----OBL---

(1) READING LAMP ON THE DESK SHED GLOW ON
(2) REA----------O------D----SHED-GLO—O—

(1) POLISHED WOOD BUT LESS ON THE SHABBY RED CARPET
(2) P-L-S-----O---BU—-L-S-—O------SH-----RE—-C-----

These results were achieved with the forgotten classic *Jefferson the Virginian*. Shannon adds that “newspaper writing, scientific work and poetry generally lead to somewhat poorer scores.”[24]

The result is simultaneously an obliteration of the guesses by the insistent reduplication of the text and an insistent appearance of the guesswork through this same reduplication. The correct guesses or dashes in Line 2 mark the differentiation of information and redundancy. This differentiation allows a “reversible transducer” built around the redundancy of the language to reconstitute the encrypted text, and to re-write the entire message (the novel) from the reduced text.

Of course, what interests Shannon, in showing the redundancy of the English language both in print and within each and every one of us, is the fact that we can reproduce the text, almost telepathically writing novels we have never read. The reduced and encrypted text in Line 2 is a kind of staccato recording of the singular moments of the guessing subject. As Shannon makes clear, the second line contains the same information as the first: an “identical twin” could reconstitute the first line from the second, could write the entire novel from the sequence of Line 2’s. This twin must be “mathematically” identical and not merely “genetically” identical.[25] The twins are reversible transducers, producing the same statistical stutter of guesses and approximations. What is left over is the singularity of a subject who is not identical to the redundant language implicit within knowledge itself, a redundancy composed of passages and quotes of English, and that saturates and encodes a mathematically identical twin. Another voice mutters beyond the stutter of the printed texts that fill given a stream of discrete symbols representing an information source. Between the appearance of discrete symbols that “tend” towards a language and the continuous bodies of cloned twins almost telepathically communicating the text of novels, is a concept of information that is radically material and embodied. As Jacques Lacan, who spent most of his 1956 seminar discussing Shannon’s information theory, noted: “one can speak of code only it is already the code of the Other, and that is something quite different from what is in question in the message.”[26] Or, in the words of “Shannon’s maxim,” a reformulation of Auguste Kerckhoff’s basic laws of cryptography from a hundred years before: “the enemy knows the system.”

The problem is not “decontextualized” information but that all our means of dealing with information are informational. Information is shot through with contexts. The goal should not be contextualization but recontextualization. Keep in mind that the semantic notion of information as meaning, or the related pragmatic notion of information as precepts or rules, emerges in an early modern process of translating and socializing an older notion of information as in-forming potential. In Thomist and medieval philosophy, the Latin *informatio* described the in-forming of matter by an active principle, which was in turn perceived by and informed the mind. Henry Peacham's 1593 *Garden of Eloquence* rhetoricized *informatio*. As synonym of the figure *diatyposis*, *informatio* is where "the speaker or orator commendeth certain profitable rules and precepts to his hearers and to posterity."[27] Peacham is clear: *informatio* is a form of speech, a figure that makes description persuasive. The description itself, the information conveyed, is the rhetorical accomplishment of the figure. For this reason, Peacham warns against the misuse of *informatio*: "abused by false prophets and teachers, by wicked princes, ungodly parents, and ungracious councilors." Already the *form* of information is associated with power and authority. By the time of Dr. Johnson's 1755 dictionary, "information" is primarily defined as "intelligence given," and only later as "the act of informing or actuating."[28] The definition schematizes the rhetorical success: the form hides its in-forming in the pragmatic information content that results. But it is the hidden figure that matters. Shannon's engineering problem is the return of this information crypt. What interests me is the reoccupation or *umbesetzung*, in Hans Blumenberg's terms, of the ontological problematic of form and event by the schematization of information as semantics and enabling institutional frameworks.[29] The secrecy of information becomes a reflection on and working through of the paradox of inaccessible yet present quasi-transcendental form, where I adapt Rodolphe Gasché's reading of "quasitranscendental" infrastructures in Jacques Derrida, and where "quasi" intensifies both the transcendental and the elusive differential quality involved.[30]

Shannon's information theory is premised on a discrete information source, which "may be thought of as generating a message symbol by symbol," as the model for all information sources. The linearity of information is a prerequisite for transmission, though such linearity can only be understood as an outcome of transmission and as a representation of a source from the perspective of a completed information circuit. The enabling metaphor is, in fact, the metaphoric linearity and cohesion, spacing and closure, of books. The temporality where information expresses itself and is expressed turns out to be represented by reading. Information sources need not be textual but they must hold together "like" a book and re-occupy the *topos* of the book.

Shannon's available knowledge on redundancy in language was from cryptography and poetics. His claim that "two extremes of redundancy in English Prose are represented by Basic English and by James Joyce's work *Finnegan's Wake*," positions the literary as the hypothetical extreme of pure information.[31] Recall here Ted Nelson's foundational claim that "literature is debugged" as a prompt to create hypertext as a system that would extract just this functioning.[32] Nelson's aim in inventing hypertext was the apparently inexhaustible intertextuality supposedly available in literature. Shannon, meanwhile, makes no other reference to Joyce, while Umberto Eco's adaptation of information theory to semiotics turns to Petrarch as an example of non-redundant information text, perhaps because Eco already wrote a book on Joyce.[33] The use of literary examples in recent theories of information, such as Hayles', continues the presupposition of the literary as the singular hardware of information.

Roman Jakobson's adaptation of information theory to a structural explanation of language required only a movement from Shannon's office down the long corridors of MIT, Shannon's diagram now in place in Jakobson's "Linguistics and Poetics" essay. Shannon's communicational circuit provided structure to the Formalist theory of poetic defamiliarization that Jakobson imported from Russia. So it is that technology transfers work: the conceptual needs of the new discipline name and bring out what was latent all along. The poetic is placed in the diagram, later to be circulated back and reincorporated into informatics and cryptography. The poetic names a surplus redundancy, encoding and encrypting the force of information within semantics. The figural complex of the poetic represents the temporal surplus of information.

The famous notion of the poetic as a surplus, as projection of "the principle of equivalence from the axis of selection into the axis of combination," offers up a code for the informatic self-production of redundancy, for the work of code.[34] "Projection" captures the encryption of information within the redundancy of semantics, a mnemotechnic rhythm of information coupling prior to representation. Jakobson's supplementation of Shannon's theory responded to Mackay's "search for basic symbols" and founded more than simply the disciplines of semiotics: it founded a pursuit of the sign as fundamental activity that we continue today, a continued production of signifying material and a continued belief in this production as the outcome though not the mirror of the real. This opacity maintains the privilege of language as an all-purpose medium, and maintains the claims of literary criticism even beyond the pertinence of Jakobson's writings to disciplinary fashions. The key is the purported "projection." Even if we no longer remain committed to “the poetic,” we still are persuaded that some value is produced in the codework of language. The mechanism of this residue is quite clear in Jakobson: similarity projected onto contiguity casts a readable figure onto language.

The latest measure of information reintroduces value as a intra-systemic shadow of an inaccessible outside or hardware. “Logical depth,” as developed by Charles Bennett at IBM, is increasingly adopted as a standard in network administration, digital security, and other fields, to measure the complexity of outputs – of whatever sort: numbers, images, etc. – *qua* underlying algorithmic processes. Bennett proposes depth as a “formal measure of value.”[35] In the background is a notion adapted from Alan Turing’s theory of computation, which takes the complexity of algorithmic output and the non-compressibility of algorithms as models of complexity in general. Complexity is value. “The value of a message thus appears to reside not in its information (its absolutely unpredictable parts), nor in its obvious redundancy (verbatim repetitions, unequal digit frequencies), but rather what might be called its buried redundancy – parts predictable only with difficulty, things the receiver could in principle have figured out without being told, but only at considerable cost in money, time, or computation.”[36] The outer limit of logical depth, however, is physical complexity. Despite the physical Church-Turing thesis, which posits that we can model all entities algorithmically, physical hardware proves to be incomputable. Instead, it is the non-programmability of this physical dimension that enables the spaces and images of computability. This physicality is an absolute depth and the basis against which value is measured, copyrighted and marketed.

Far from Mackay's careful quantification and balancing of accounts, depth frustrates any logical tally.

As a result, all information tends towards the cryptographic ideal of a "one-time pad," a simple and supposedly unbreakable cipher. In general, cryptography encrypts a plain text message by combining it with a key or encrypting text following some method or algorithm. The most immediate way to decode a cipher given only the encrypted text is to search out regularities or redundancies, clues to the key and method used. A one-time pad demands a random key of exactly the length of the plaintext. The random key possesses no internal structure, no redundancy, while the fixed length prevents any repetition, a classic error offering mathematical clues about the key. The unbreakability of the one-time pad is its algorithmic complexity: with no redundancy at all, the time spent reconstructing the plain text from encrypted message by pure guesswork is prohibitive to the point of impossibility. One-time pads were in use by cryptographers since at least Gilbert Vernam's patent of the algorithm in 1917. Its mathematical formalization as a "one-way function" formed the basis for the Stanford Digital Encryption Standards (DES), now in place for all digital communication.

Of course, the unbreakability of the one-time pad requires its proper use. Most of all, this means an absolutely random key. As Friedman points out, books were the traditional source of random cryptographic keys. Just pick up your favorite novel for a source with sufficient randomness. The one-time pad seems to destroy this method, though digital encryption consultants still advise us to type a "favorite poem" when generating random bits for PGP encryption. Better yet, "spice" up the poetic phrase with informational redundancy – that is, create a pseudo-random string following Shannon's practice of itinerant codework. Resist Security offers the not unreasonable password "Willy Wonka meets the Terminator" and spices it up to "willywoNKA meet$ the^ terMIN@tor." In strict accordance with Friedman, they add: "NEVER WRITE YOUR PASS PHRASE DOWN!"[37]

Nevertheless, the one-time pad would seem to require a different complexity than that offered by texts. The dream of contemporary cryptography is using quantum sources to produce random keys. The limits of digitally generated random sources are the on-off states of bits. The complexity of such a source is limited by the combinatory possibilities of the bit-set. The wave-particle duality of quantum sources, by contrast, means that quantum bits can be in multiple states, 1 and 0 at the same time, oscillating at 32-bits or 4,294,967,296 values in a single calculation. Rather than generating a random key from the pulse of the computer's clock, the typical source for pseudo-random number streams, quantum cryptography generates keys from light, using the polarization basis of photons in a fiber-optic cable. A leading technology in the field is MagiQ's Navajo, a product name that cites the Second World War use of the improbability of Native American languages as a cryptographic technology. In this linguistic transfer we see the absolute materiality promised by the "white mythology" of light as the current state of information's aesthetics.

The premises of “traditional cryptography” assumed a single key, however random, and thus a single plain text. Quantum-generated random keys destroy this self-evidence by creating an oscillating number stream with no regular states. With the key and the encryption process no longer accessible to the senses, quantum cryptography would seem to bring about the end of the “textuality” of information. In fact, the uncertainty and inaccessibility of the quantum is not simply the end but the apotheosis of the book, the seemingly final exemplification of the complexity of the literary. Quantum cryptography is an infinitely deep source of decryption, just as Shakespeare was for the Friedmans. The point is not that quantum cryptography is in some way literature but that the “form” of its complexity is modeled on the complexity of texts and best exemplified by literary texts. The current code situation extracts what literary materiality promised all along: non-codedness.

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[1] William F. Friedman, “The Use of Codes and Ciphers in the World War and Lessons to be Learned Therefrom,” *Cryptography and Cryptoanalysis Articles Volume 2*, Ed. William F. Friedman (Laguna Hills, CA: Aegean Park Press, 1976), 192-205, at 204.

[2] William F. Friedman, *Elements of Cryptoanalysis* (Laguna Hills, CA: Aegean Park Press, 1976), 138.

[3] William F. Friedman, *Six Lectures on Cryptoanalysis* (Laguna Hills, CA: Aegean Park Press, undated), 9, quoting *Time* magazine.

[4] Jackson Mac Low, *Representative Works: 1938-1985* (New York: Roof Books, 1986), 71.

[5] *The American Heritage Word Frequency Book*, Ed. John B. Carroll, Peter Davies, Barry Richman (New York: American Heritage Publishing, 1971), 601

[6] Mac Low, *Representative Works*, 96.

[7] Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication* (Urbana, IL: University of Illinois Press, 1963), 43-44. In between are “first order approximations,” where letters appear in their frequency (OCRO HLO RGWR NMIELWIS EU LL NBNESEBYA TH EEI ALHENHTTPA OOBTTVA NAH BRL), “second order approximations,” where digraphs occur according to their frequencies (ON IE ANTSOUTINYS ARE T INCTORE ST BE S DEAMY ACHIN D ILONASIVE TUCOOWE AT TEASONARE FUSO TIZIN ANDY TOBE SEACE CTISBE), “third order approximations,” where trigraphs occur according to their frequencies, (IN NO IST LAT WHEY CRATICT FROURE BIRS GROCID PONDENOME OF DEMONSTURES OF THE REPTAGIN IS REGOACTIONA OF CRE), and “first order word approximation,” where words appear according to their frequency (REPRESENTING AND SPEEDILY IS AN GOOD APT OR COME CAN DIFFERENT NATURAL HERE HE THE A IN CAME THE TO OF TO EXPERT GRAY COME TO FURNISHES THE LINE MESSAGE HAD BE THESE).

[8] Ibid., 44.

[9] Ibid., 44.

[10] *American Heritage Word Frequency Book*, xiii.

[11] See Sandy Baldwin, “Process Window: Code Work, Code Aesthetics, Code Poetics,” *The Cybertext Yearbook*, 2002-2003, (Jyvþskylþ: University of Jyvþskylþ, 2003), <need page numbers>.

[12] Shannon, *The Mathematical Theory of Communication*, 34.

[13] Ibid., 31.

[14] N. Katherine Hayles, *How We Became Posthuman* (Chicago, IL: University of Chicago Press, 1999), 11.

[15] Ibid., 18.

[16] Ibid., 54-56. See Mark Hansen, *New Philosophy for New Media* (Cambridge, MA: The MIT Press, 2004), 78-81.

[17] Donald Mackay, *Information, Mechanism, and Meaning* (Cambridge, MA: The MIT Press, 1969), 2.

[18] Ibid., 3.

[19] Ibid., 4. See Anselm Haverkamp's discussion of scientific photography in "Chaos by Design: The Light Sound Constellation," *MLN* 118.3 (2003) 688-703.

[20] Ibid., 43. This is an example: the metaphor appears repeatedly.

[21] Ibid., 41 and 42.

[22] Hayles, *How We Became Posthuman*, 56.

[23] Hans Ulrich Gumbrecht, "A Farewell to Interpretation," *Materialities of Communication*, Ed. Hans Ulrich Gumbrecht and K. Ludwig Pfeiffer (Stanford, CA: Stanford University Press, 1994), 389-402, here 398.

[24] Claude E. Shannon, "Prediction and Entropy in Printed English," *Bell Systems Technical Journal*, 31:1, January 1951, 50-64, at 54 and 56.

[25] Ibid., 55.

[26] Jacques Lacan, *Écrits: A Selection* (New York: W. W. Norton & Co. 1977), 305.

[27] Henry Peacham, *The Garden of Eloquence (1593)* (Gainesville, FL: Scholar's Facsimiles & Reprints) 92-93.

[28] See Rafael Capurro, "On the Genealogy of Information," <http://www.capurro.de/cottinf.htm>, accessed Dec. 8, 2004.

[29] See, for examples, Part II, Chapter 2 of Hans Blumenberg, T*he Legitimacy of the Modern World* (Cambridge, MA: The MIT Press, 1983), 137-144.

[30] Rodolphe Gasché, *The Tain in the Mirror* (Cambridge, MA: Harvard University Press, 1986), 316.

[31] Shannon, *The Mathematical Theory of Communication*, 56.

[32] Ted Nelson, *Literary Machines*, in *The New Media Reader*, ed. Noah Wardrip-Fruin and Nick Montfort (Cambridge, MA: The MIT Press, 2003), 446.

[33] Umberto Eco, *The Open Work* (Cambridge, MA: Harvard University Press, 1989), 58-61.

[34] Roman Jakobson, "Linguistics and Poetics," in *Style in Language*, ed. T. Seboek (Cambridge, MA: The MIT Press, 1960), 350-77, at 358.

[35] Charles Bennett, “Logical Depth and Physical Complexity,” *The Universal Turing Machine – a half-century survey*, Ed. Rolf Herken (Oxford: University of Oxford Pres, 1988), 227-257, at 230. See Friedrich Kittler’s brief but valuable comments on “logical depth” in “There is no software,” *CTHEORY*, 10/18/95, < http://www.ctheory.net/text_file.asp?pick=74>, accessed Dec. 9, 2004.Ibid.

[36] Ibid.

[37] Bill Morton, “The Beginner’s Guide to Pretty Good Privacy,” resist.security.ca, < http://security.resist.ca/bg2pgp.shtml >, accessed Dec. 8, 2004.