Not Quite so Crazy After all These Years: Pynchon's Creative Engineer

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Critics have not usually been very flattering in their judgment of John Nefastis, the inventor of the Maxwell's Demon machine in *The Crying of Lot 49*. Edward Mendelson thinks his science is "unbalanced," and regards "the whole effect" of Nefastis's description of his machine as "one of Blavatskian mumbo-jumbo" (Sacred 126, 129).[1] Tony Tanner dismisses Nefastis as "a lunatic" who believes in "a crazy fantasy of his own making" (184). Katherine Hayles describes Nefastis's machine as "a demonic version of the two-cycle engine that drives the novel," and as "a demented attempt to escape universal heat death" (112, 113). Others draw attention to the implications of his name: "unholy, unclean, abominable" (Palmeri 982); "unspeakable to the gods" (Nicholson 101); "perhaps 'nefarious': . . . evil or impious" (Abernethy 25). Frank Palmeri also rather unkindly suggests that Nefastis's crewcut and Polynesian shirt identify him immediately as an "unmistakable science nerd" (982). Certainly the engineer's reference to "young stuff" and his inappropriate assumption that Oedipa is sexually available do not indicate a highly evolved consciousness.

And yet, when Nefastis is first mentioned, there seems good reason to regard him sympathetically. "'John's somebody who still invents things,'" Stanley Koteks tells Oedipa, indicating that Nefastis is to be counted among those "'really creative engineer[s]'" stifled by the patent-grabbing policies of corporations like Yoyodyne (85). In a world where originality, uniqueness, difference are likely to be the only means of salvation in the face of an increasing tendency toward uniformity, such a person is surely someone to be valued. Perhaps the gods to whom Nefastis is "unspeakable" are in fact the gods of corporate America, the stultifying powers whose monopolistic control of the means of communication is one of the novel's prime targets.

At the same time, of course, we must deal with the fact that, at least from Koteks's perspective, the Nefastis machine represents a creativity that defies the constraints not only of the corporate legal structure but also of the physical laws of the universe. We might be tempted to feel that Nefastis's creativity has pushed him over the brink.

Oedipa's immediate response—"'Sorting isn't work?'" (86)—shows that she senses something amiss in Koteks's account of the Nefastis machine, and the reader familiar with the history of Maxwell's Demon and the discussion it has given rise to will recognize the implicit legitimacy of her objection. A number of scientists have undertaken to demonstrate in various ways why Maxwell's tiny, intelligent being could not in fact perform as its postulator supposed it might. A 1929 paper by Leo Szilard is usually cited as the opening salvo in the bombardment. Briefly, Szilard argued that the degree of ordering (or decrease in entropy) that results from the demon's perceptions is negated—or "offset," to use Nefastis's term—by the increase in entropy that necessarily accompanies any measurement. The sorting Oedipa refers to that the demon is supposed to perform can be achieved only at the expense of an increase in entropy associated with the demon's ability to gather information about the system in which it is confined. Szilard's analysis was extended in the early 1950s by Leon Brillouin, who assumed the demon would need some form of light source not in equilibrium with the system to perform its sorting task. At least in terms of Koteks's account, Nefastis is evidently misguided if he indeed thinks his machine can contravene the second law of thermodynamics.

However, we should be careful not to judge Nefastis solely on the basis of Koteks's description, which is by no means complete. Thus, for example, Peter Abernethy's claim that Nefastis "evidently" holds an "obsolete view" of the physics involved in his invention (23) seems premature, justified as it is by reference to what Koteks tells Oedipa. I would like to argue that Nefastis and his machine have been to some extent both misunderstood and misrepresented, and that his own attempted explanation to Oedipa contains evidence that he is less misguided than some commentators have maintained.

The narrator's/Oedipa's précis of Nefastis's explanation is no doubt extremely familiar, but a great deal hinges on the way that account is rendered, so I reproduce it here for the sake of accuracy:

> He began then, bewilderingly, to talk about something called entropy. The word bothered him as much as "Trystero" bothered Oedipa. But it was too technical for her. She did gather that there were two distinct kinds of this entropy. One having to do with heat-engines, the other to do with communication. The equation for one, back in the '30's, had looked very like the equation for the other. It was a coincidence. The two fields were entirely unconnected, except at one point: Maxwell's Demon. As the Demon sat and sorted his molecules into hot and cold, the system was

> said to lose entropy. But somehow the loss was offset by the information the Demon gained about what molecules were where.
>
> "Communication is the key," cried Nefastis. "The Demon passes his data on to the sensitive, and the sensitive must reply in kind. There are untold billions of molecules in that box. The Demon collects data on each and every one. At some deep psychic level he must get through. The sensitive must receive that staggering set of energies, and feed back something like the same quantity of information. To keep it all cycling. On the secular level all we can see is one piston, hopefully moving. One little movement, against all that massive complex of information, destroyed over and over with each power stroke." (105–06)

First, and perhaps rather tangentially, Oedipa apparently feels that Nefastis's discomfort with the word "entropy" not only equals but actually resembles her own unease over "Trystero," an unease presumably stemming from her inability to ascribe an unambiguous meaning to the name. Nefastis may well be "bothered" by a similar ambiguity associated with the concept of entropy, particularly when its use in connection with the fields of thermodynamics and statistical mechanics is complicated by the introduction of ideas from information theory, as is the case here. Physicists and literary critics alike confidently define the concept according to their own lights, thereby creating the kind of competing associations that probably trouble Nefastis.[2]

In thermodynamics: entropy is the measure of "certainty of information about the system" (Tanner 184); "it could be regarded as a measure of the 'uncertainty' of the actual quantum state" (Denbigh, Entropy 105); "with the state of higher entropy we associate the concepts of greater freedom, uncertainty, and more configurational variety" (Gatlin 30); it "measures the degree of randomness of a system" (Gatlin 26); it is "a measurement of the unavailable energy . . . in a system" (Kharpertian 102); it is "the quantitative measure of the degree of disorder in a system" (Arnheim 8); at the same time, however, "Disorder and chaos . . . do not mean a random jumble of things but rather uniformity, a lack of distinctions, a sameness, a lack of individuality, a tendency toward complete conformity. It is a 'steady-state' in which 'matter and energy' are evenly distributed" (Abernethy 20); finally, it is "'the degradation of the matter and energy in the universe to an ultimate state of inert uniformity'" (Abernethy 20). In information theory: entropy is "the measure of uncertainty in a system" (Tanner 184); it "represents a measurement of possibility" (Schaub, Voice 57); it "signifies the disorder within any set of possible communications or messages" (Nicholson 101); it measures "the decline in amount of information delivered" (Eddins 100); it "measures, not the information of the sender, but the ignorance of the receiver that is removed by the receipt of the message" (Edwin T. Jaynes, quoted in Palmeri 997n); it is "a measurement of a message's uncertainty as a function of the number of possible messages that can replace it" (Kharpertian 102); it is "a measure of the uncertainty of the message *before* it is chosen, out of all the alternatives from the same set of events; equally it is a measure of the information *after* the message has been chosen" (Denbigh, Entropy 104). Who wouldn't be bothered by a concept that lends itself, apparently quite readily, to so bewildering a variety of explanations? Let us suppose, for the sake of argument, that Nefastis's discomfort reflects his familiarity with the complexities of the subject rather than his ignorance, which would more likely lead to a kind of complacent assuredness.

Just what knowledge base Nefastis is working from is difficult to ascertain, however. Critics have not exactly helped by ignoring Nefastis's reference to "the '30's" and succumbing instead to the widespread habit of referring the reader to the work done in 1948 and 1949 by Shannon and Weaver. Everyone seems to agree that Claude Shannon's 1948 paper in the *Bell System Technical Journal* broke new ground in the development of mathematical communication theory. Anne Mangel, whose article is often cited in this context, reproduces both Boltzmann's "equation for entropy in a system" and Shannon's for "the average information-per-symbol," showing that the two not only "looked very like" each other but were identical (202). The problem lies in the fact that Nefastis does not refer specifically to Shannon's work, but to two equations that appear to pre-date it by a decade or more. Thus, when Thomas Schaub asserts that "Nefastis knows that his belief in his invention's workability rests on a visual metaphor: the identity of the equations for 'entropy' in thermodynamics and the average unit in information theory" (Voice 57), he seems to have been reading Shannon (or Mangel), not Pynchon. Palmeri's insistence that Pynchon "satirically undercuts Nefastis's outdated conceptual model [by] juxtaposing the explanatory models of Shannon and Brillouin" (983) reveals a similar tendency.

If we are to follow Nefastis's explanation in any detail, we have to look for equations other than Shannon's that forge a link between "heat-engines" and "communication." Shannon himself provides some guidance here when he acknowledges his debt to the work of R. V. L. Hartley, who published a paper on "Transmission of Information" in the *Bell System Technical Journal* in 1928. Seeking to define a quantitative measure of information, Hartley concludes that "the logarithm of the number of possible symbol sequences" constitutes such a measure. Where H is "amount of information," and n is the number of selections made from among s, the number of symbols available at each selection, then, Hartley concludes, $H=n \log s$ (540). "If we put n equal to unity," Hartley continues, "we see that the information associated with a single selection is the logarithm of the number of symbols available" (541). Where $s=2$ (in a binary choice, for example), $H=\log 2$. Hartley's definition coincides very well with Szilard's finding that "the mean value of the quantity of entropy produced by a measurement is $S=k \log 2$," where k is a constant (127). The measurement Szilard refers to is a binary one—an indication of whether a piston should be moved up or down. Given this juxtaposition, it is hard not to conclude that $H=S$, or that "entropy" and "amount of information" are, or can sometimes be regarded as, equivalent.[3] There is no particular difficulty involved in such a conclusion, provided it is understood that entropy here is a measure of the thermodynamic cost of obtaining a particular amount of information: to get H, you have to "spend" S.[4]

Nefastis accepts the assertion that, in most cases, the similarity of the two equations is merely "a coincidence." In doing so, he takes one side in a debate that is by no means settled even today. While some take the work of Szilard and Brillouin to establish literal congruence between information and entropy,[5] others are skeptical at best.[6] Interestingly, Nefastis expresses what appears to have been a minority view in his day. After Brillouin went beyond Shannon to postulate "a direct connection between information entropy and thermodynamic entropy," according to one account, the scientific community was split, though by no means evenly. "If the subsequent literature accurately reflects level of belief, the believers are more numerous" (Leff and Rex 20). However, Nefastis does follow the majority in identifying the Maxwell's Demon hypothesis as the locus of the greatest congruity between the two concepts.

The demon in Nefastis's machine must decide at each stage whether a given molecule belongs in section A or section B of the closed system. To determine the appropriate destination for the molecule in question, the demon must somehow perform a measurement that establishes a value of greater than or less than x, where x is the mean kinetic energy of the gas molecules in the box. This is precisely equivalent to the situation of Szilard's hypothetical observer, and thus justifies the assumption that the increase in entropy associated with the demon's choice is exactly equal to the amount of information it has gained. This equivalence explains why Nefastis tells Oedipa the decrease in entropy the demon brings about in the system is "offset" by the information it gains about "what molecules were where." Thus, rather belatedly, we can answer Schaub's question in his 1976 open letter to Edward Mendelson why the narrator uses the word "but" in the passage—"but somehow the loss was offset" (94). Nefastis realizes that the demon's capacity to lower the entropy of the system by shunting the molecules into two separate enclosures is "bought" at the expense of a rise in entropy equivalent to the amount of information obtained. The "but" points to his recognition of this fact. There is no "murkiness" here, as Palmeri maintains (982); nor is there any inherent disagreement with the model proposed by Brillouin, to which Palmeri appeals to demonstrate that Nefastis is working with an "outdated conceptual model." Despite finding Szilard's model "very curious (and rather artificial)," Brillouin nonetheless shows that, "even in such an oversimplified example," the results agree with his own conclusions (136).

Nefastis, then, is not so foolish as to suppose he has invented a *perpetuum mobile* of the second kind. He knows, if Koteks doesn't, that "mental work" has a thermodynamic cost. His solution, of course, is to provide for an external source of energy in the form of the "sensitive." I am giving Nefastis the benefit of the doubt on his assumption of the demon's literal existence and of certain persons' capacity to communicate psychically with the demon. Kolodny and Peters rather sympathetically include Nefastis among those who have been "disillusioned or cheated by the various American Myths" (81), and I have already noted that we can view him as among those who oppose the drive toward cultural uniformity the novel appears to criticize.

So far, so good. But just what does Nefastis mean by his description of the energy flow of his system? He seems to say, in more or less impressionistic terms, simply that the sensitive "feeds" the demon with some kind of energy that enables it to continue sorting the molecules indefinitely. This is somewhat vague, however, and we must look more closely at what Nefastis tells Oedipa if we are to understand him better.

The machine's actual mechanical operation is not specified, so we are left to speculate just how the demon's sorting translates into the movement of the two pistons. Presumably, what happens is this: the demon "collects data" on each of the molecules, directing the faster ones into one portion of the box—a cylinder, for our purposes; the cylinder heats up, causing the piston on that side of the machine to rise, while the other piston sinks as the temperature of its cylinder drops. When all the molecules have been accounted for, the demon simply reverses direction, thus heating up the opposite cylinder.

Among the several difficulties the demon faces in performing its appointed task, perhaps the most relevant to our purposes is that posed by thermal fluctuation. Because the demon is part of the system it inhabits, it is vulnerable to disturbances resulting from collisions with gas molecules and photons from blackbody radiation. These disturbances are likely to be compounded by the heat/information it absorbs from the measurements it performs (Leff and Rex 11). "'If we assume that the specific heat of the demon is not infinite, it must heat up. It has but a finite number of internal gears and wheels, so it cannot get rid of the extra heat. . . . Soon it is shaking from Brownian motion so much that it cannot tell whether it is coming or going, much less whether the molecules are coming or going, so it does not work'" (Richard Feynman, quoted in Leff and Rex 11). The implication is clear: "If a demon heats up, periodic dumping of energy to an external reservoir is needed to keep its temperature approximately equal to the temperature of the gas in which it resides. . . . Of course, feeding entropy to the reservoir helps to keep the second law intact" (Leff and Rex 11).

To perform cyclically, the demon must periodically be returned to its initial state—one in which it is once again capable of performing its measurements accurately. The demon, in other words, must be "reset." This is surely the process Nefastis describes when he says "The sensitive must receive that staggering set of energies, and feed back something like the same quantity of information." The "staggering set of energies" is the thermodynamic result of the demon's acquisition of information. As we have seen, the demon acts as the kind of measuring device Szilard describes. Each measurement it makes generates an entropy equivalent to k log 2, so the total entropy per cycle would be that amount multiplied by the number of measurements—the number of molecules in the box. (We have already noted that this amount can be regarded as equivalent to the amount of "data" the demon has accumulated, via the congruence of Hartley's quantitative measure and Szilard's "entropy cost" calculation. Perhaps the slight difficulty inherent in Nefastis's remark about passing on data is removed by this association.) Because the entropy of the gas is reduced by the demon's sorting, the increase in entropy must be located in the demon itself. If the system were indeed a closed one, the massive increase in the demon's entropy each cycle would soon render it incapable of performing its task unless it could channel the entropy to an outside "dump" or "garbage can."

But the entropy the demon dumps represents degraded energy—energy drawn from the system by the process of observation and dissipation. For the system to "keep cycling," an equivalent amount of non-degraded energy must be returned to the demon (Leff and Rex 13–14). Here we run into an easily perceivable difficulty—one that has been advanced by physicists uneasy with the subjectivist implications of attempts to link thermodynamics and information theory:

> In general it seems difficult to conceive of many situations in which "information" . . . can be made use of by humans, or by automata, for the purpose of seizing hold of the momentary fluctuations which occur within physicochemical systems. Of course it must be accepted that the Second Law is a statistical law, and is only true on the average. Therefore it would not be really shocking (only very, very surprising) if we did sometimes succeed in trapping such systems in slightly low entropy states. On the other hand it would be exceedingly shocking, as well as surprising, if a sequence of symbols on a piece of paper, or inscribed on a magnetic tape, or held in someone's head, were ever capable of being the *cause* of such an event. (Denbigh, How 114)

Nefastis, however, clearly conceives of information as a kind of energy, presumably on the basis of the "'objectively true'" (106) relation between information and entropy Maxwell's Demon establishes. He is not alone in making this connection. Norbert Wiener, for example, acknowledges that "there is no sharp boundary between energetic coupling and informational coupling" (37). Speculation in the early sixties about information processing by computers also suggested a connection between logical processes and their physical constraints.[7] Nefastis's belief in the capacity of a sensitive to communicate with the demon indicates his assumption of a physical channel through which a certain amount of energy in the form of "information" can be sent to the demon to restore it to a state in which it can perform a new set of measurements. "Information" here seems a physical equivalent of "capacity to process knowledge," a sense not too distant from its usage in the field of communication. The sensitive gauges the necessary "quantity of information" from the "data" the demon has passed on to her—a simple enough calculation given the equivalence of Hartley's and Szilard's equations.

The lesson to be learned from all this is that Nefastis does not really think he has invented a perpetual motion machine. When he talks about "all that massive complex of information" being "destroyed over and over," he is more or less explicitly acknowledging the energy cost of keeping his machine cycling. However, because the energy source is a "sensitive," readers have tended to dismiss Nefastis as some kind of unbalanced zealot. At the same time, those same readers have been willing to draw the analogy between Oedipa and the demon, suggesting that she attempts to sort the various clues her investigations turn up just as the demon attempts to sort the molecules. Surely the parallel is stronger if we recognize—as many critics have—that Oedipa too must receive some form of input from outside her normal range of reference if she is to follow Inverarity's advice to "'keep it bouncing'" (178). The Nefastis machine as I conceive of it seems a much better model for Oedipa's predicament than the putative closed system envisaged by the majority of commentators. Even if we do regard Nefastis as a sexist nerd, we have to remember that nerds have a tendency to be a great deal smarter than their judgmental peers.

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Notes

[1]Mendelson once felt that the "language of belief" associated with Nefastis was a shaky endorsement of his science. However, in a review of Schaub, Mendelson acknowledges that he has been persuaded by Schaub's less positive views on "the degree of affirmation present" in the novel (44).

[2]The reader whose first thought is that the proffered definitions are anachronistic in relation to Nefastis's supposed frame of reference should consult Leff and Rex's chronological bibliography, which cites over eighty potential sources of information on Maxwell's Demon and entropy that predate the publication of *Lot 49*.

[3]"It is clear that Hartley's definition of quantity of information agrees with Planck's definition of entropy if one correlates equivalent messages with independent wave functions" (Rothstein 105).

[4]Having made the transaction, however, you can, at least according to some theorists—most notably, Brillouin—claim that the information gained constitutes a drop in the entropy of the system. The common tendency to think of entropy as inversely related to information can be traced to this claim. When Tanner, for example, identifies an increase in the thermodynamic entropy of a system with an increase in "the certainty of information about the system" (184), he is espousing this view. As certainty increases, amount of information decreases. Hartley's quantitative measure is not incompatible with this view, since H obviously increases with s, the number of symbols available to be chosen. If s is high, the amount of uncertainty removed by choosing from among the possibilities is correspondingly high.

[5]See, for example, Philip Rodd: "The question has been posed as to whether the connection between entropy and information is limited to a mathematical similarity or whether there is really some physical connection. We show that there is a definite physical relation between the two" (145).

[6]"[T]his formal similarity does not imply that the functions necessarily signify or represent the same concepts. The term 'entropy' had already been given a well-established physical meaning in thermodynamics, and it remains to be seen under what conditions, if any, thermodynamic entropy and information are mutually interconvertable. . . . My own view is that the interconvertability thesis can be maintained only in certain special cases where it becomes trivially true, due to the reference to 'information' being unnecessary" (Denbigh, How 113).

[7]See, for example, Rolf Landauer. Leff and Rex note that Szilard's paper contains the seeds of later speculation about the cost of information erasure (16).

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