Entropy and Utopia @ Zero Hour: Modernity and the Manhattan Project

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Abstract: This paper critically reexamines the canonical utopic scene from the end of Johann Wolfgang von Goethe's *Faust II* (1832) through the writings of the British-born Yale physicist Dr. William Francis Gray Swann (1884–1962), who composed one hundred years later a book on the philosophy of contemporary physical science titled *The Architecture of the Universe* (1934). In his text, Swann invokes the instrumentalization of atomic energy in a bargain to defeat a cosmic anxiety borne from the modern temporal experience of *entropy*, a pact whose culmination is akin to Faust's seminal turning away of the ghost Sorge (Care), with strong ramifications for the future postatomic world order. The physical initiation of this "zero hour" is best known through the work of Swann's Ph.D. student, Ernest Orlando Lawrence, who went on to pioneer the mass separation of electromagnetic isotopes at Oak Ridge. This paper will posit the Manhattan Project as part of the legacy of a pre-war universal imaginary, in order to introduce a new critical reading of utopia in Germany's greatest poet.

Keywords: Ernest Lawrence, Faust, Johann Wolfgang von Goethe, Entropy, Manhattan Project

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I. Oracles

On the evening April 18, 1935, the British physicist and Yale professor William Francis Gray Swann delivered the Penrose Memorial Lecture, titled "Is the Universe Running Down," at the American Philosophical Society in Philadelphia.[1] Asked to explain the second law of thermodynamics to a sophisticated but largely nonspecialist audience, Swann enlists the aid of what he curiously called a "cold and supercilious" oracle, a conjured spirit who transports him to face a desert plane, where a storm rises and distributes quantities of sand across its surface.[2] After several storms rise and die with no visible change to the barren landscape, Swann asks the oracle what it is they are waiting for, to which the oracle replies:

> We are waiting, until, by accident, the storm will one day blow the sand into the form of a cathedral, and by accident blow from afar such ingredients as mixed with the rain shall produce the cement which by accident may fall in such places as are necessary to cement the cathedral together and make a permanent structure. (Swann, "Is the Universe Running Down?" 221)

Swann's oracle, whom we might name Entropy, illustrates in this example the express disinterest of nature in creating intelligible human symbols. Refusing to say that a cathedral built by the processes of nature is impossible, Entropy takes a certain glee in proclaiming the absolute improbability of such an event. Much to Swann's dismay, Entropy explains that the loose sand and rock blown about by the desert storm were once parts of beautiful natural formations, or perhaps even cities and buildings. Nature's material temporal direction is singular—it points always towards the nonsymbolic future, towards a disordered equilibrium and a flattening of all structure. The desert storm reveals that to the laws of nature, there is no hierarchy or preference given to edifice, however rich and magnificent; in other words, the distinction between the beautiful and the barren is illusory. Swann's employment of a mediating agent sets up a clear dynamic of opposition between Entropy and an empathetic figure—Swann himself as the subject in dialogue with the oracle. In his dream, Swann repeatedly asks Entropy what can be done to reverse this tendency, whether any human action, such as the willful creation of a structured object like an intricate house, could contribute to, rather than subtract from, the total amount of order in the universe. The oracle answers that the heat energy needed to create such a house would be largely dissipated rather than utilized, assuring Swann that any architecture—no matter how beautiful—could never contribute positively to the total amount of perceived order in the universe. This has the apparent effect of thrusting the author, and his audience, into a state of gloom and despair.

This being the Philosophical Society, it is not impossible that more than one member of the audience will have caught the similarity between Swann's oracle and that of another allegorical figure which appears to a different purveyor of the world, also a scientist, in the history of German literature. Here I refer to the figure of Care/Sorge, an "oracle" who appears at the end of the second part of Johann Wolfgang von Goethe's *Faust II*, published one century earlier in 1832. Care appears at the twilight of Faust's life, signaling the coming stillness of death, an "everlasting dusk descending" where "night has nested in his soul." Faust's rejection of Care, and his subsequent being blinded by her, is a critical moment not only in the play itself but also in the history of Western utopian thought in general—it precedes the famously envisioned scene of the building of a new society in which "millions" will have a "new living-space," "free at last," in "constant daily strife," on a new "pleasant earth." As his final act, a forceful act of imagination, Faust replaces an entropic vision of time (the coming stillness of death) with a counteracting, utopian vision of endless progressive activity. To understand the internal struggle between entropy and utopia within Faust, we turn to a passage from the scene titled "High Mountain" in act 4, in which Faust reveals to the demon Mephistopheles his conception of nature's power as being fundamentally purposeless, from the David Luke translation:[3]

> 10212 Landward it streams, and countless inlets fill;
> Barren itself, it spreads its barren will;

It swells and swirls, its rolling waves expand
Over the dreary waste of dismal sand;
Breaker on breaker, all their power upheaved
And then withdrawn, and not a thing achieved!
I watched dismayed, almost despairingly,
This useless elemental energy!
And so my spirit dares new wings to span:
10220 This I would fight, and conquer if I can

(Goethe, *Faust, Part Two* 180)

Despite their differences of elemental illustration (fire and wind for Swann, water and land for Goethe), the image of Faust observing the useless swelling and withdrawing of waves can indeed be compared to Swann waiting in the desert for a cathedral to appear out of wind-blown sand. Both scenes describe a kind of useless elemental energy and a sense of the barren will of nature. The allegory of Care can be in this way read as an analogue for Swann's oracle—both represent a figure which seeks to convince their listener of the primacy of entropy, of Newton's second law in the world.

II. The Violence of Utopia

Both scientists suffer a sense of despair and helplessness, and ultimately both reject the nihilistic implications of their respective oracles' message. Where they differ is in the realm of possibilities and mode of their rejection. Faust's repulsion toward the purposelessness of nature's energies results in the conjuring up of a new utopian plane, brought about by his great design in opposition to nature: It is a work of artificiality against the sublime forces of nature, a work which exists outside of it. This opposition is critical here. For Faust, the primacy of the energies of nature would appear to be matched only by the counter-primacy of man's will (nature seems always to be Female, in Swann as well) as two equal but opposite systems. It is in their opposition, then, activated by a "constant daily strife," an activity which must constantly rebalance or "reconquer" through artificial means the natural "danger" of the world which surrounds this new abode, that defines what might be the final condition of Faust's famous wager with Mephistopheles—a paradoxical lingering in a moment defined by action.

And for Swann—having received the lesson of his oracle who "guards within his consciousness the laws by which the universe is governed" ("Is the Universe Running Down?" 218)—he sees himself not in opposition to, but rather governed by, those very laws which he intuitively resists. Contrary to a traditional oracle who might possess certain incomplete insights into the mystical mechanism of fate, in Swann's version of the classical mechanistic imaginary, Entropy *is* fate; and thereby fate becomes equated with mechanical law. In his desperation, Swann begins to bargain with his oracle, and enquires whether a "revolution [might] occur which will improve the lot of those poor people whom I see yonder, and the lot of humanity in general?" The oracle replies solemnly, "No, a revolution might improve, temporarily, the lot of the people you speak of, but it would destroy civilization

somewhere else to such an extent that the world, or the universe as a whole, would be worse off than it was before" (218). The world as Swann's oracle describes it is truly a closed system—there are no openings in its ground plane through which any activity may escape or provide resistance from an exterior position. To the figure of Entropy, guardian of the second law, human action and natural action run always in the same direction—to an eventual equilibrium of all forces—a "limit of chaos" in which "all men shall be equal," "safe, secure, and stable" (220). Swann goes on to explain:

> Nature is like human beings. Human beings will permit sections of society to exist in different states of prosperity, but whenever she gets a chance in the form of a revolution, things so arrange themselves that the revolution reduces the disparity. . . .[4] The second law of thermodynamics . . . is thus the most politically radical doctrine in the universe. (220)

Here we can note that, after being blinded by Care in act 5, Faust describes his utopian project as a place where men are "free," but never does he claim that they will be equally free. Rather, he says specifically that they will "not be safe, but active" (11564). Freedom and safety are pitted here against equality in a rather unexpected opposition. Read in the context of an inherently revolutionary tendency of nature, the Hungarian Marxist philosopher Georg Lukács's claim that "like Goethe," Faust is "the opponent of all revolution,"[5] would appears to be exactly right, and exactly wrong. The utopic moment is indeed formed not incrementally, but suddenly. But from the perspective of our twentieth-century interlocutor, Swann and the oracle Entropy, Faust's revolutionary demand for the momentary execution of a grand scheme in order to change radically the state of humanity, creating a place where the "multitude" can stand, a "free people on free land," can only be accomplished through a sudden and vast condensation of energy. The massive expenditure required to raise artificial lands to reclaim the sea would only ultimately accelerate the purposeless mechanism of nature rather than oppose it, aiding an indifferent process which always moves toward the true ultimate community of equals, with "no kings, no presidents, no government"—a still community of the dead (Swann, "Is the University Running Down?" 220). It is important to note here that such a reading of nature does not only reach towards a disintegration of the distinction between the symbolic and nonsymbolic, but that it also moves toward a state of indifference between violence and action in general. The labor required for the execution of Faust's utopian project—the "toil of a thousand hands"—is meaningless when seen as a function of time coldly subject only to available material.

More recent criticism of this canonical scene has brought this point precisely to bear. In her chapter "Faust's Building: Theory as Practice," Claudia Brodsky expounds upon what she perceives as the violence inherent in the Faustian vision, which seeks to create "a place which is an origin, an origin which is a place" (32). Pointing to the grave discrepancy between freedom and justice, Brodsky will argue essentially that it is simultaneously both of these conditions flattened in time that produce the utopia's base condition. Violence is born in the temporality of Faust's demand for "immediacy": of the need to satisfy the moment as ultimate aesthetic experience, through the collapse and enfolding of the universal into the particular, "architectonic vision" into "architected matter," ends into means, theory into practice. The point of Brodsky's argument, however, is not to argue that all utopic thought is violent, but rather to reveal the relationship between violence, time, and material. Utopia was the means to

"store" and "contain" life itself in a place "beyond," outside of time which is also a means of extending indefinitely and forever Faust's deal with the devil Mephistopheles. Faust's "decidedly modernist" land reclamation project is thus a sort of communal cryogenic container of vital life force which is simultaneously a selfish bid for the salvation of his soul—a tangible form capable of storing, condensing and ostensibly releasing the intangible spirit without fusing to it biologically. All this, in order to fend off the overwhelming and terrifying entropy that threatens the very idea of subjective action itself, which promises to flatten subject and object, individual and society, denying the possibility of any ontology within its confines. It is at this very moment, that Swann makes his own wager with the devil.

III. Animating the Inanimate Universe

The lecture of 1935 followed on the success of a book published by Swann in the previous year, 1934, titled *The Architecture of the Universe*, in which it is revealed that the story of the oracle Entropy was set up somewhat disingenuously with an answer already in mind. Envisioned as a synthesized compendium of past lectures to the public, *The Architecture of the Universe* was meant to introduce the theoretical implications of modern atomic physics to the "educated layman." Highly poetic and avoidant of "mathematical symbols" (v-vi), Swann posits in the book that the steps with which we arrive at a theory of entropy in the universe are actually dependent on an unspoken agreeance upon our collective experience of time in modernity. The "stout devotees of the second law of thermodynamics," Swann explains, have elevated the idea of natural equilibrium—one which states that nature always seeks the most the most probable state of things—into a universal law. Cosmic anxiety is thus painted as spiritual dogmatism, guarded by those who "feel that processes which would reverse the march towards chaos—processes such as the reformation of electrons out of radiant heat energy—are contrary to the scheme of nature" (246).

What is at stake is the fundamental philosophical question of what to make of one's reality, whether the present configuration or state of things (a society, for example) are sufficient grounds to make inductive claims regarding the laws that govern them. To this end, Swann acknowledges that the pendulum of scientific revelation would seem to swing public sentiment exactly between a resistance to radical deductive alternatives on one end, and an equally hard conservatism (upon their eventual acceptance) on the other.[6] The agency of thought in the collective subject "we" is thus the key component of his argument.

> It is not so much that the entropy of the universe is increasing with time, as the fact that we have unconsciously ordered the events of the universe in a sequence of increasing entropy, and then used the progression of events indicated by that sequence as the symbol of the progression of time. (372)

Swann is able to make such a statement, of course, because he is reading the Newtonian second law of thermodynamics from an Einsteinian perspective of relativity, which does not allow for the verifiability of a subjective experience of time as an a priori metric, but rather sees that one's

experience of time is in fact dependent upon one's movement and velocity through space. With the transfiguration of absolute space or absolute time into a system of interrelations, the uniform directionality of time, then, is destabilized. This is largely standard knowledge in modern popular science, but what is interesting is that in Swann's interpretation of the general theory of relativity, the collective experience of increasing entropy is itself a symbol of the passing of time, a sign whose structurality the oracle has, like Mephistopheles in *Faust*, covered over with a veil. This is evident when this symbol is not referred to an ethereal or material but rather social phenomenon, bound and limited on a Euclidian plane of consciousness. That is, because we all share an identical perspective in the wider scheme of space-time relative to one another and the earth, we are also bound to the same structural configuration of matter, which dictates the probability of events in our collective experience. This is why the oracle in the desert is absolutely confident in taunting Swann with the idea of accidental structure as miracle. Swann thus suggests that relativity challenges the dogmatism of Newtonian rationality with regard to probability and chance as a function of time. Taking the last step, Swann affirms that chance and probability, which seem in the example of the desert to govern the relentless winding down of the universe, are to be understood themselves as merely earthly symbols, stand-ins for greater unknowns.

Swann ultimately steps away from such speculations to engage in a reading of the relativity theory that allows him to address directly the "law of chance" in the world where he, and we, live. In a universe "running down," the banishment of chance is the only way to envision the durability of form. Swann will reveal that up until now, he has only been describing half of what he believes to be the universal equation—the category of what he calls the inorganic. In a chapter called "Vital Processes," Swann posits that the observational discovery of the atom and its behaviors poses a fundamental challenge to precisely the entropic notion of time as progressing only toward a state of maximum probability (chaos). "Sooner or later, the philosophy which has sought to penetrate the secrets of inanimate matter must include in its scope the story of life" (*Architecture* 376). Swann proceeds to give three classifications of animated, organic matter: that which can be deduced by present laws of physics and chemistry, that which can be induced by those laws, and finally that which falls outside and requires an "appeal to a wider system of laws than those comprised under chemical or physical laws in the ordinary sense of the words" (376).

Far from an attempt to submit the reader to a harshly mechanistic world-view, it turns out that this last category is the location of Swann's real interests. While the chapter name recalls the work and philosophy of the contentious scientific field known as vitalism,[7] Swann avoids the phenomenological connotations of defining the third class of life as a hypothetical named substance, invoking rather the observable instability inherent in statistical probability itself as a yet another stand-in or symbol of a "more complete formulation of the detailed laws in whose terms there would be no necessity for statistical considerations" (390). He focuses on the potential for spontaneous, sudden, and unexplained changes in the states of physical objects—such as the random excitability of electrons at rest—to point to rare "discontinuities" in the physical world. Swann will ultimately posit that perhaps mechanical, causal, deterministic history proceeds in finite intervals punctuated by "sharp boundaries of discontinuity in which new alignments of the quantities which specify the system take place" (381). For Swann, these "discontinuities" do not violate or alter the reliability of existing physical or chemical laws on a general level. Rather, that they necessarily fall outside of any stable, sustained

statistical index registers the potential for a free will enabled by a stochastic metaphysics (389). For the human experience, Swann counts among the primary registration of "discontinuities" the appearance of miracles and the "experience" of death (384).[8]

Swann concludes his address at the Penrose Memorial Lecture with precisely the "incomplete knowledge of the laws of atomic processes" ("Is the Universe Running Down?" 245). Shaking himself free of the oracle's hold with new-found knowledge of the unstable particle, he asks:

> It is true that the evidence of our experience teaches us that the devouring process would go on much more slowly when the stars were old; but eternity is long, and there is plenty of time. Is there any way back from radiant energy to matter? (247)

This time, he answers his own inquiry in the affirmative.

> Now the idea is that on certain rare occasions, a photon comes into such violent collision with the nucleus of an atom as to result in a kind of catastrophe. In this catastrophe nothing in particular happens to the atomic nucleus, but the photon becomes mathematically irritated in such a manner as to cause it to decide to change its existence, commit suicide, and become resurrected as a pair of charged particles. If you should ask for a crude analogy, I suggest that you think of a spiritualistic séance. The photon is the ghost, the pair of charged particles constitutes the materialized ghost, and the atom is the medium. (247)

Free from the divine at last and master of his own destiny, Swann can pose now seriously the task of "rebuilding" the universe. The "organic" instability of atoms might be encouraged such that its miniscule force could grow one day to balance out and harmonize against the force of entropy (*Architecture* 391). In other words, the concept of entropy is at bottom what animates and motivates the desire for the discovery of a "miraculous catastrophe." Far from the conceptual, it is the instrumentalization of this "miraculous catastrophe" that is all too real: its legacy may be found most directly in Ernest Lawrence's mass proton accelerator the cyclotron, the critical precursor to the efficient processing of Uranium-235. Completed at the University of California, Berkeley in 1930, it was the end result of a long series of studies begun from his time at Yale as a Ph.D. student in the 1920s. His advisor was Dr. William Francis Gray Swann.[9] Swann was a highly influential figure on Lawrence; it was because of Swann's leaving Yale in 1926 that Lawrence had decided to move to Berkeley in the first place. Swann's writing affords us here a strangely poetic look at the events that unfolded that are of course not directly resultant from it, but can nevertheless be viewed through the lens of an existential anxiety rooted in the eighteenth-century scientific imagination.

It is difficult to imagine that Lawrence's cyclotron was not on Swann's mind when he develops in 1934 this idea that the entropy of the world might be counteracted by the image of the doubling and "resurrecting" photon, a form whose life is spontaneously conceived through the violent collision of death. The stochasticity of the operation seems to symbolize for Swann a transcendent moment in which the particles exhibit a kind of free will outside of causal-deterministic systems (*Architecture* 382-383). The chapter titles of his book produce a clear schematic of the argument: free will, a

manifestation of "Vital Forces (Chap. XI)," stands in clear opposition to the mechanistic "Fate of the Universe (Chap. VI)," which concludes in paraphrase of "the words of Prospero, [envisioning] the day when these dumb actors on the stage of nature shall have vanished into thin air, into less than air; when the great nebulae of space, the planets, and all which them inhabit, when our great sun and the very stars of heaven have dissolved and left not a wrack behind" (251).

It is therefore the combination of a naïve vitalism and the sincere wish for epistemic transcendence which allows for Swann to imagine that the enormous amount of energy released back into the world through atomic fission could enter as *constructive* material. This naïveté must be fairly qualified as one which is not bound to a lack of scientific foresight—in 1934, the practical uses of the "new science" being explored were not directed towards military purposes until after the outbreak of war in Europe. Rather, it is the weight of history which reenters the frame and imposes on this period of modernity (before 1945) the tragic aura of an innocence forever lost. It reveals in hindsight the violent spark already apparent in the force and earnestness of Swann's wish to displace the Newtonian universal with a vital epistemology liberated from the grey and bitter reality of mechanistic law.

Like Swann's illustration of the "spiritualistic séance," in which a pair of charged particles derive from a single original photon, the ideas *Entropy* and *Utopia* share between them a universalized conception of temporality. As if the operation is performed in reverse, it is the sudden devastation wrought in the medium of a concrete historical moment that synthesizes this temporality in an instant and reveals the truth of their constructed opposition. The entropic, in the Newtonian sense, denotes an existential finitude of matter and energy, a sense of teleological angst regarding their expenditure that becomes in turn a measure of the finitude of time. And the counteractive concept of utopia, from the Greek *utopos*, contains the classical dual meaning of "good place," as well as "no place." The rhetorical and philosophical negotiations performed by the protagonists of this essay, the physicist Dr. William Francis Gray Swann (1884–1962) and the Faust of Goethe's *Faust II* (1832), is that both seek to displace one universal with another. The two figures, one fictional and one real, form an unlikely comparison which nevertheless illuminates a shared rejection of mechanical law by forceful acts of imagination. In both instances, a great shout into the void aims to disrupt the unbroken continuity of time with stochastic blasts of energy, an injection of spontaneity borne from the violent manipulation of individualized units. In the latter, it is the "toil of a thousand hands" banded together in a negative and beneficent world of stillness. And in the former, it is the chain-reactive splitting of isotopic atoms that demarcates without exaggeration a "zero hour" of modernity in the eruptions over Hiroshima and Nagasaki.

Notes

1. William Francis Gray Swann was the first director of the Bartol Research Foundation at the Franklin Institute. He was a prolific scientific researcher and career academician who specialized in particle physics and cosmic radiology, and who in his later career (1930s onward) turned to popularizing these concepts for laymen and media. He was a fellow of multiple distinguished academic associations and holder of honorary degrees from Yale, Swarthmore, and Temple universities. The source for this note and location of Swann's papers is the American Philosophical Society (Mss.B.Swl): search.amphilsoc.org/collections/view?docId=ead/Mss.B.Sw1-ead.xml#bioghist.
2. The "second law of thermodynamics" was embedded in the popular scientific imagination of the early twentieth century,

seemingly especially with British scientists such as Swann or Arthur Eddington, who wrote, for example: "The law that entropy increases—the Second Law of Thermodynamics—holds, I think, the supreme position among the laws of Nature" (Eddington and Callaway 74).

3. Claudia Brodsky also begins her critical text *In the Place of Language* on Faust's building with a concept of purposelessness derived from these lines: "It is no longer the uselessness of human learning and knowledge that inspires Faust's anger, but rather nature's inhuman lack of vision and ambition" (31).
4. As if pre-empting the Faustian counter-argument, here Swann describes in a footnote a power which seems to describe exactly the Faustian idea of *striving*: "However, this analogy must not be pressed too far; for human beings seem to possess the power to recreate the disparity again" ("Is the Universe Running Down?" fn. 2, 230).
5. See Lukács, *Faust und Faustus*, p. 177. Here is a reading of Faust's "new ground" as the "highest aim of humankind."
6. This is clearly shown in chaps. 1 and 2, respectively titled "Medieval and Modern Dogmas in Natural Philosophy" and "The Dawn and Development of the Modern Era" (Swann, *Architecture* 1-43).
7. See Hans Driesch, *History and Theory of Vitalism*. Macmillan, 1914.
8. "Death would constitute, as it were, the master discontinuity or group of discontinuities, following which the history of the organism would go on according to the ordinary continuous laws of physics without the occurrence of any further discontinuities of the kind under discussion" (Swann, *Architecture* 384).
9. See Richard Rhodes, *The Making of the Atomic Bomb*. Simon and Schuster, 1986: "As far back as his first year of graduate school, 1922, Lawrence had begun to think about how to generate high energies. His flamboyant, fatherly mentor encouraged him. William Francis Gray Swann, an Englishman who had found his way to Minnesota via the Department of Terrestrial Magnetism of the District of Columbia's private Carnegie Institution, took Lawrence along with him first to Chicago and then to Yale as he moved up the academic ladder himself. After Lawrence earned his Ph.D. and a promising reputation Swann convinced Yale to jump him over the traditional four years of instructorship to a starting position as assistant professor of physics. Swann's leaving Yale in 1926 was one reason Lawrence had decided to move West, that and Berkeley's offer of an associate professorship, a good laboratory, as many graduate-student assistants as he could handle and $3,300 a year, an offer Yale chose not to match" (144).

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