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Medieval World View in Modern Jargon [Review of Entropy: A New World View by Jeremy Rifkin]

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"made it evident that legal protection for power seekers. The royal family and court study power and its acquisition the way the Gallos study wine. They communicate easily in several complex languages via subtle hand and finger gestures unnoticeable to outsiders. Children are trained in manipulative techniques as soon as they are teachable. The Atreideses, as consummate philosopher kings and queens, struggle constantly with their desire to wield the forces of government for good without being corrupted or destroyed.

In the latest Dune book, the power theme is developed even further, perhaps to the detriment of the plot. Even by Herbert fans, the book has been criticized for a weak story line.

Leto Atreides, 3,000 years after he donned the sandworm skin, is actually being transformed into a sandworm himself. The lack of action, I think, can be forgiven in light of the delightful intellectual change that Leto, equipped with complete ancestral memory, undergoes. He becomes the center of religion because of his god-like powers of prediction and manipulation along with his huge worm shape. Leto's powers dwarf those of the predecessors.

The first three books deal with the moral and psychological dilemmas inherent in wielding power. The author's conflict between the effort to make rulers real and rulers heroes comes to a head in Leto. Finally, the only way to make the emperor a hero is to set him against himself. For example, Leto sets out to cure the universe of hero worship. The god-emperor becomes a "predator," seeking out and destroying those who are unfortunate enough to fall for his line.

As Leto's actions grow more onerous, his motives grow clearer. Early in the novel he tells an old friend: "We are myth-killers. . . . That's the dream we share. I assure you from a God's Olympian perch that government is a shared myth. When the myth dies, the government dies." In the same vein, Leto warns, "Power bases are very dangerous because they attract people who are truly insane, people who seek power only for the sake of power."

These are not new thoughts, but they are well stated in context and represent a fairly sophisticated conception of politics. I wonder if the philosophical evolution of the Atreideses is not really the story of Frank Herbert's evolution. The author even turns against heroes of the earlier novels, casting unfavorable light on those previously presented as relatively unblemished. What comes across in *God Emperor* is that Frank Herbert is extremely interested in, even fascinated with, the nature of government and power, and he has managed to communicate a good deal of his passion. The reader may not agree with all of his theories (for example: one of the major causes of war is latent homosexuality that comes into play in all-male militaries), but many are thought-provoking ("Scratch a liberal and you'll find an aristocrat").

Leto's power and his plans to rid the universe of governments and restore Dune to its desert state are finally threatened by his love for a woman. The end of the book is ambiguous, almost necessitating another sequel. But that's fine—a lot of people like the series.

If you liked the first three, you'll like the new one. If you haven't read them, be careful. I read the first three in less than a week only a year ago. My work, my health, and my love life suffered. *God Emperor of Dune* got me again!

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ENTROPY: A NEW WORLD VIEW

By Jeremy Rifkin (with Ted Howard); afterword by Nicholas Georgescu-Roegen

New York: Viking Press. 1980. 285 pp. $11.95. Bantam. 1981. $3.95.

REVIEWED BY JEFFREY ROGERS HUMMEL

Entropy looks to be emerging for the '80s what *ecology* was for the '70s: a trigger word much misused by those within and commenting on the environmental movement. Very few of Jeremy Rifkin's ideas are original, but he is an effective journalist who has readably packaged the thoughts of others in order to popularize them. As a result, those who want to deal intelligently with environmental issues will find themselves forced to delve into the esoteric subject of entropy.

In 1868 a German physicist, Rudolf Clausius, first introduced the term *entropy*. Since then, entropy has become one of the more important, albeit elusive and difficult, concepts in modern physics and chemistry. It has to do with energy conversions, with transforming energy (the capacity to do work) into work.

The first law of thermodynamics states that energy can be neither created nor destroyed but only converted from one form to another. Einstein's special theory of relativity modified this law slightly by pointing out that matter can be converted into energy and vice versa. The second law of thermodynamics states that, in an isolated system (that is, a system in which there is no exchange of either energy or matter with the outside), the only energy transformations that can occur are those that result in an increase in the entropy of the system.

Now, what is this entropy? It is a measure of the quantity of energy in the system that remains unusable because it cannot be converted. The reason it cannot all be converted is *heat*. Heat is itself a form of energy, but a strange bird among them. While nonthermal forms of energy (mechanical, electrical, etc.) can be totally converted to heat, the reverse is not true. How *much* heat energy can be transformed is determined by the relative temperatures of whatever is conveying the heat and its environment; the smaller the difference, the less energy can be extracted—or, the greater the entropy. For instance, drop an ice cube into a glass of scotch, and heat is transferred from the scotch to the ice cubes. The ice melts and the scotch cools until a uniform temperature obtains. The entropy of "the system" has increased.

Even in conversions between other forms of energy (say mechanical to electrical), some heat is created, and so some energy becomes unusable. Hence the second law of thermodynamics—that in an isolated system, energy conversions increase the entropy of the system.

Rifkin's *Entropy: A New World View* (written with the assistance of Ted Howard) would be an easy book to dismiss. For Rifkin, the second law of thermodynamics is *the* supreme law of the universe that explains everything else. Why do we have double-digit inflation in the United States today? Easy! Because entropy is increasing. Why is government getting more powerful? To contend with increasing entropy. Why do we have pollution, crime in the cities, and a rising incidence of cancer? You guessed it—entropy.

Rifkin not only explains all current social problems with entropy, but all of human and natural history. The Industrial Revolution, the invention of the cross-plow, the class differences in the materials used for clothing in 19th-century Britain, and the economic ideas of Adam Smith were all a direct consequence of the inexorable operation of what he calls the Entropy Law.

Any scientist with even rudimentary training in thermodynamics will throw this book down in disgust. One can gauge the depth of Rifkin's understanding of entropy by turning to page 33 and discovering that the popular maxims "You can't beat the system" and "It does no good to cry over spilt milk" capture the essence of the first and second laws of thermodynamics.

Rifkin's treatment is so amateurish that he cannot even keep straight the distinction between matter and energy. For example, Rifkin informs us that "if we burn a piece of coal, the energy remains but is transformed into sulfur dioxide and other gases." How interesting to learn that sulfur dioxide is a form of energy. Most chemists and physicists suffer from the delusion that it is a form of matter. They further believe that when coal is burned, the *matter* is transformed into *carbon* dioxide and other gases, while the *energy* is transformed into heat and radiation.

Rifkin commits a somewhat less obvious but no less serious blunder when he portrays statistical thermodynamics as the last-ditch effort of conservative, short-sighted scientists to deny the truths embodied in the Entropy Law. In fact, statistical thermodynamics provides the theoretical underpinning for the second law. Rifkin sustains this imaginary conflict by presenting a gross caricature of classical mechanics and coupling it with an uncomprehending objection to the very concept of statistical probability.

Typical of Rifkin's economic expertise is the following: "Contrary to the prevailing wisdom, applying more and more energy per individual in order for each person to survive is not more efficient—that is, if efficiency is properly defined as a reduction in work." The thermodynamic concept of efficiency is very different from the economic concept, but neither of them is remotely similar to Rifkin's alleged definition. Efficiency, in either case, is a ratio of outputs to inputs. In thermodynamics, it is the ratio of the total work output of a thermodynamic system to the total energy input. In economics, efficiency is the ratio between some product output and its cost input.

Measuring economic efficiency requires that product output and cost input be quantified. And since the value of any product output and its accompanying cost depend on people's preferences, any statement about economic efficiency must, in the final analysis, be grounded in people's preferences.

Rifkin's failure to grasp the nature of economic value is evidenced when he chastises economists for their inability to "get it into their heads that machines and people can't create anything." No economist has ever contended that people can create matter or energy, but the fact that people can, by transforming matter and energy, create value for themselves and others is undeniable. Taking seriously Rifkin's theory of value would force us to conclude that a Rembrandt painting is less valuable than the paints and canvas that went into its production because entropy increased during the process.

Rifkin's blindness to the preferences that underlie value leads inevitably to an arrogant willingness to impose his own tastes as universal imperatives. "Any honest appraisal," Rifkin has the gall to inform us, "is sure to conclude that most of what is manufactured in our economy is simply superfluous."

The discerning reader will be prone to disregard Rifkin's book. He parades his distrust of reason. As a result of the Entropy Law, he says, "A gut reaction . . . is more reliable than a reasoned decision," and "it is better to trust your instincts . . . than your intellect." He hates the Industrial Revolution, the Enlightenment, the Renaissance, indeed all of civilization. He waxes lyrical about the static medieval world view as compared with the subsequent mechanical paradigm and its pernicious purveyors, Bacon, Descartes, and Newton. His ideal society predates even the Agricultural Revolution—the human species was in its Golden Age when everyone was a member of small bands of hunters and gatherers.

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Rifkin would love to see a return to the idyllic hunter-gatherer existence. But the increase in the earth's entropy has been of such magnitude since the Agricultural Revolution that such a backward step is now out of the question. We will all have to settle for something less: a modern variety of subsistence, brought to us via decentralized socialism in which we once again rely solely upon the sun and, presumably, oxen for energy.

But to ignore Rifkin's book would be a grave mistake. Rifkin has thrown together the ideas of about half a dozen less-careless but less-accessible authors. Of all his intellectual precursors, the most important is Nicholas Georgescu-Roegen, who wrote the afterword for Rifkin's book. In works such as *The Entropy Law and the Economic Process*, Georgescu-Roegen has pioneered an extremely powerful, although severely flawed, thesis about the social significance of the second law of thermodynamics. Unless we take this "entropy" thesis seriously and systematically refute it, it will achieve far more influence than it merits.

Energy exists in one of two states—*available* or *free* energy and *unavailable* or *bound* energy. Every energy transformation entails the conversion of some free energy into bound energy and a consequent entropy increase. If, within a thermodynamic system, the quantity of free energy decreases, entropy necessarily

must have increased somewhere *outside* the system. Over the universe as a whole, the total quantity of free energy is continuously declining. Ultimately, in several trillion years or so, the operation of the second law of thermodynamics will bring about the heat death of the universe, in which all free energy has been converted into bound energy, entropy has been maximized, and the universe has become a homogeneous mass of gas of uniform temperature.

The significance of these facts for the human species is that all production—indeed, all human action—utilizes energy and therefore converts free energy into bound energy, increasing entropy. Once people have tapped a particular source of free energy, that energy is no longer available for human purposes.

Rifkin, following Georgescu-Roegen, sees this truth as reinforcing with ironclad immutability the case for limits to economic growth. Entropic degradation is inevitable and irrevocable. Eventually, people will deplete all possible sources of free energy. The higher the level of economic development, the greater the rate of this depletion, and the shorter becomes the expected life of the human species. Rifkin and Georgescu-Roegen want to slow human-caused entropy increases to a minimum in order to prolong the existence of the species.

Following are some of the more telling criticisms that can be made about this line of argument:

1. The earth is not an *isolated* system. At every instant in time, the earth is continuously bombarded with free energy from the sun and continuously radiates energy into space. For practical purposes, the earth can be treated as a *closed* system, one that like an isolated system cannot exchange matter with the outside but unlike an isolated system exchanges energy with its surroundings. (Strictly speaking, even this is not correct.) Because a closed system can exchange energy, the entropy of a closed system can either increase, decrease, or remain constant. Thus, it is impossible to say, *a priori*, as does Rifkin, that entropy on the earth is increasing.

2. In a subtle nuance that will escape many readers, Rifkin tries to escape the implications of the fact that the earth is not an isolated system by introducing what he calls the fourth law of thermodynamics: "In a closed [notice that Rifkin says "closed," not "isolated"] system, the material entropy must ultimately reach a maximum." Rifkin only mentions this fourth law once, in passing, but he implicitly relies on it throughout his book. This fourth law, I suspect, is the source of Rifkin's constant confusion of matter with energy.

Do not, however, strain your eyes trying to find this important fourth law of thermodynamics in any standard physics, chemistry, or thermodynamics text. Not that Rifkin made it up. No, he got it from Georgescu-Roegen—who made it up. Since the traditional concept of entropy is rigorously defined, the first question to ask about his new law is the meaning of the phrase "material entropy." How does it differ from regular entropy? Unfortunately, nowhere in any of his writings does Georgescu-Roegen make an effort to give a precise definition of it. Without such a definition, the "fourth law of thermodynamics" remains utter nonsense.

3. Because the earth is not an isolated system the entropy of the earth is not necessarily increasing. But what of the sun, the source of the earth's flow of free energy? What can the second law tell us about the sun? It is definitely true that the sun is burning out. If the sun continues to radiate energy at the same rate that it has for the 6 billion years that it has already been in existence, it will cease being a source of free energy in a little more than 30 billion years. By comparison, *homo sapiens* has inhabited the planet for no more than 500,000 years. Nothing we do can possibly affect the time horizon of the burn-out of the sun.

4. The limitations mandated by the second law are not only irrelevant to human time horizons; they are also irrelevant because of human inability to exploit all sources of free energy. Many potential sources of free energy remain untapped and possibly untappable by humans, including the energy available from lightning, from the temperature differences in the oceans, and from the eruption of volcanoes. All the earth's free energy will be dissipated, with the entropy of the earth at a maximum, when the earth joins the rest of the universe as a homogeneous gas at heat death. The human species will have encountered limitations upon usable energy well before that point.

Rifkin implicitly recognizes this objection in his section "Nonrenewable Energy," in which the Entropy Law becomes a superfluous trapping to an unoriginal discussion of the exhaustion of nonrenewable energy stocks. That the stocks of such energy sources as coal and petroleum are finite is an obvious fact. Introducing the second law of thermodynamics adds nothing to its importance or implications. Talking about entropy when one is really concerned about finite stocks of natural resources merely obfuscates the dialogue.

5. Even if none of the above criticisms held, all Rifkin would have succeeded in proving is that energy is scarcer than generally believed—so scarce that one generation can only prosper at the expense of a future generation. Since scarcity is one of the fundamental concepts of economic theory, economics is perfectly capable of dealing with this extreme case.

Rifkin again displays his economic ignorance when he charges "that there is no way to allow for the needs of future generations" in classical economic theory." In fact, there is a great body of economic work explaining how, through the operation both of the interest rate and of entrepreneurial profits for speculators who predict future scarcities, the market provides the most efficient allocation of resources over time. Rifkin's claim that "no one speaks for future generations at the marketplace" is simply wrong. If he were really correct about the dire implications of the Entropy Law, then instead of fleecing the public with stupid books, he could make a fortune speculatively withholding energy sources for future generations—and provide a bona fide public service while at it.

In conclusion, Rifkin's book, in its attempt to integrate the physical sciences with the social sciences, ends up abysmally feeble in both areas. Rifkin's crank presentation of the "entropy" thesis, as well as Georgescu—Roegen's more-respectable version, is nothing better than pseudo-science. It will be a genuine misfortune if the environmental movement adopts the "entropy" approach. The only possible outcome will be a neglect of legitimate environmental concerns as the environmentalists discredit their movement.

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