

Entropy Means Freedom

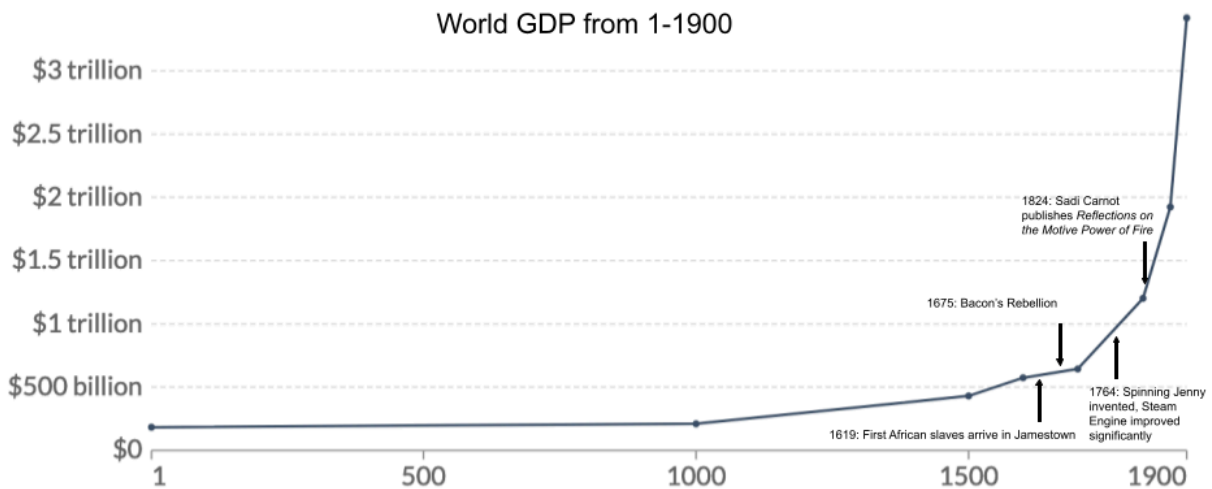
“No one really knows what entropy really is”
—John Von Neumann

why the meaning of entropy matters

Some people say that entropy is a probability-based concept that pops up in thermodynamics and information theory. Translation— something only STEM nerds are supposed to care about. But others insist that entropy means chaos and disorder. If you accept this definition, the Second Law of Thermodynamics, which states that all closed systems inevitably tend towards entropy, has deep political implications because our entire physical universe is a closed system. Conservative neo-Hobbesian intellectuals like Jordan Peterson employ the Second Law to suggest that, since all systems break down, to preserve “Western civilization” for as long as possible we need hierarchical social structures.

As usual, the right-wing view is incomplete at best and fear-mongering at worst. Entropy may mean chaos, entropy may mean disorder, but entropy also means freedom. To the extent that the concept applies to human politics, we should embrace entropy instead of fighting it.

a brief timeline of industrialism



Jamestown was founded in 1607. By 1617, cotton is grown for export along the Powhatan River. In 1619, the first slave ship arrives from West Africa. In 1662, the children of slaves are declared to be slaves themselves by a legislature controlled by wealthy planters. In 1675, Bacon's Rebellion temporarily unites African slaves and poor Europeans, many of whom were indentured servants, against the wealthy planters. In 1680, blacks are denied freedom of assembly to prevent future uprisings. In 1691, interracial marriage is outlawed. After 1692, blacks can no longer own livestock. By the 1700s, African chattel slaves make up half of Jamestown's unfree labor force.

In 1764, James Hargreaves conceives the idea for the spinning jenny, a labor-reducing, cotton-weaving machine.

In 1764, James Watt notices that Thomas Newcomen's steam engine wastes a lot of steam and improves it from 1% to 2% efficiency.

By 1775, Richard Arkwright combines Watt's steam engine with Hargreaves' spinning jenny to build mills where the entire process of spinning slave-grown cotton into yarn is carried out by a single machine. This marks the start of the Industrial Revolution and the exponential economic growth that underlies what you think of as "Progress".

reflections on the motive power of fire

In 1824, the 28-year old French engineer Sadi Carnot publishes a book titled *Reflections on the Motive Power of Fire*. In his introduction, he writes:

Notwithstanding the work of all kinds done by steam-engines, notwithstanding the satisfactory condition to which they have been brought to-day, their theory is very little understood, and the attempts to improve them are still directed almost by chance.

Steam engines had been powering factories, trains, and steamboats since Sadi was a little boy, and yet no one before him had proposed a scientific theory of how they actually worked. I point this out to make clear that the reason this science was discovered by European scholars and not Chinese, Indian, Middle Eastern, West African, or Mayan scholars has much more to do with cotton slavery and the resulting industrialism than comparative intellectual prowess.

Enough decolonizing; on to the science. Carnot subscribes to a Newtonian theory of heat as *substance*, an invisible thing that flows like water. He refers to it as “caloric”. He writes:

The production of motive power is then due in steam-engines not to an actual consumption of caloric, but to its transportation from a hot body to a cold body, that is, to its re-establishment of equilibrium— an equilibrium considered as destroyed by any cause whatever, by chemical action such as combustion, or by any other. We shall see shortly that this principle is applicable to any machine set in motion by heat.

According to this principle, the production of heat alone is not sufficient to give birth to the impelling power: it is necessary that there should also be cold; without it, the heat would be useless.

And later:

Wherever there exists a difference of temperature, motive-power can be produced.

If you're wondering how exactly this temperature difference can be translated into motion, consider that most materials expand when warmed and contract when cooled. In practice, steam engines used water expanding into steam in a cylinder to push a piston; Carnot points out that, in theory, you could use an expanding iron bar to accomplish the same effect.

Carnot realized that, in theory, this process was perfectly reversible. As long as you can restore the temperature differential, which in his view was just a question of moving enough “caloric” back to the source, you can produce unlimited power. Not infinite power— he goes out of his way to prove that, because of the already well-established principle of the conservation of energy(his father, Lazare Carnot, wrote his own book on the topic), the temperature differential can never be increased and therefore the power output of the engine can never *increase*— but the only reason Sadi Carnot gives for why the engine must eventually *stop* is the fallibility of human engineering.

Sadi Carnot's insights have been distilled by later scientists into the Carnot cycle, which you may have studied in high school physics. When contemporary engineers design anything from a more efficient engine to a better refrigerator, they are aiming to get as close as possible to the ideal of the Carnot cycle.

the birth of entropy

Reflections on the Motive Power of Fire languished in obscurity for ten years until it was cited by a more popular treatise by another engineer, eventually capturing the attention of the German mathematician Rudolf Clausius. It was Clausius who gave us the first definition of entropy as “the tendency of energy to spread itself out”. He phrases this in the rigorous language of calculus, but if we apply the definition back to Carnot's insights the practical implication is clear— the hot reservoir inevitably bleeds into the cold reservoir, erasing the temperature difference that powers the engine.

To Clausius, entropy means thermal equilibrium. Working with Carnot's analogy that the motive power of the “caloric” across a temperature differential is like the motive power of water across a waterfall, Clausius tells us that there is a tendency for the bottom of the waterfall to ascend and a tendency for the top of the waterfall to descend until the water stops flowing.

At the end of his 1865 paper where he perfects his definition, Clausius formulates the first two laws of thermodynamics:

1. The energy of the universe is constant
2. The entropy of the universe tends to a maximum

This is how many physicists think our physical universe will end— starheat bleeds into the dark chills of empty space until energy is evenly distributed. The lonely particles of your body, separated through trillions of cubic light-years, freeze at a temperature of almost absolute zero. An infinite wait.

why Ludwig Boltzmann invented statistical mechanics, opening the door for Niels Bohr to discover the quantum nature of energy when solving the mystery of black-body radiation

But why does entropy always increase? Most people don't spend too much time wondering this because it aligns with common-sense pessimism. To most people, perpetual motion just feels too good to be true. But surely the universe bears no special hostility to stars and engines, right? So why does entropy always increase?

By redefining entropy, Austrian physicist Ludwig Boltzmann developed the answer over the 1870s and 1880s— simply because it is more likely for entropy to increase than for it to decrease.

First, Boltzmann redefines heat and temperature. Abolishing Carnot's "caloric", he (correctly but controversially in his time) understands temperature as an emergent property of the motions of individual particles—the faster individual particles move, the higher the total temperature. This explains why solids are colder than liquids and liquids are colder than gasses.

Second, Boltzmann introduces the concept of microstates vs macrostates. A macrostate is defined by emergent properties like temperature. However, any given macrostate is consistent with many different and unique microstates. Taking the macrostate of temperature for example, given a particular microstate with N particles, each with some position and some velocity, the microstate where those N particles are in the same position but are moving the opposite way with the same speed gives rise to the same macrostate.

Third, Boltzmann redefines entropy as proportional to $\ln(\Omega)$, where Ω is the number of microstates and $\ln()$ refers to the natural logarithm. The natural logarithm is a slowly but strictly increasing function, so basically this means that where there are more microstates, there is a higher entropy. Therefore, macrostates with more microstates are mathematically preferred.

Imagine an engine with immensely hot gas in one reservoir and particles at absolute zero in the other reservoir. Though there are still many microstates in this configuration, they are far outnumbered by the microstates where all the particles are evenly spread through both reservoirs. Randomly moving particles will float into the cold reservoir. Hotter particles from the hot reservoir will bounce off cooler particles in the cold reservoir, imparting some of their kinetic energy. Through millions of these tiny random interactions, hot inevitably flows towards cold. The engine stops.

There's also an analogy with sand castles and sand dunes. If you leave a sand castle to the winds, it will be subsumed into the dunes simply because sand castles are a less likely arrangement of sand than sand dunes. But if you leave sand dunes to the winds long enough, inevitably they will build sand castles. And inevitably they will destroy them again.

closing thoughts for Marxists

It should come as no surprise that colonizers view entropy as a bad thing. The question that birthed the concept was "is there a limit to how much work can we extract from an engine?", and we discovered that when there is chaos, when there is disorder, no more work can be extracted. Even worse, the fact that this chaos and disorder always increases turns out to be a fundamental law of the universe. If your wealth and power come from controlling the machine, the fact that all machines inevitably stop must be deeply disturbing.

But the terms “chaos” and “disorder” only make sense as definitions of entropy when you take the perspective of the outsider who wants to extract work from the system. If you take the perspective of the particles themselves, it’s hard to escape the conclusion that the tendency towards entropy is a good thing. Entropy increases purely from free interactions with their fellow particles, and the state of maximum entropy is one where, although they’re all whizzing about in different directions, particles have about the same energy. For the particles, entropy means not only equilibrium but also freedom.

The global system of control we find ourselves living under operates much like an engine where wealth replaces the “caloric”. A wealth differential is necessary to compel people to work repetitively, to live repetitively, to even think and dream repetitively. As much as possible, people must be separated so that they don’t rub off on each other. State violence, like the walls of an engine, must limit the downward redistribution of wealth. In fact, it is best for them to actually increase inequality by allowing concentrated capital to colonize new frontiers. Sometimes this means selling products in “developing” countries, sometimes this means extracting resources from Indigenous lands, sometimes this means inventing the Metaverse.

Many supposedly anti-capitalist ideologies are stupid because they say “this engine bad” and propose another centralized design. As individuals, as particles, we don’t want a new framework to organize how we extract work. No, what we want is to *stop extracting work*, even work in service of the revolution. People should only work when they want to, or as their chosen community leads them to.

This is going to take, as Martin Luther King Jr. presciently observed, a radical redistribution of wealth. This can only be accomplished by abandoning all dogma and piping the wealth directly to the people. We shouldn’t care if people waste money buy designer goods to flex. We shouldn’t care if white racists support wealth redistribution but continue being racist. We shouldn’t care too much that the poor people of the global north will initially have more money than the poor people of the global south— if we truly destroy the walls of the engine in the initial struggle, any following systems of inequality and coercion will be much more temporary.

By giving people more wealth, more free time, more control over their lives, we increase entropy. People will leave abusive relationships, workplaces, towns, even countries. People will create new art, new economies, new forms of knowledge, new societies and traditions, new landscapes and worlds. This lonely, cruel, and repetitive world can be replaced with one where all the humans on this planet are healthy, happy, and free. Because entropy means freedom.

closing thoughts for post-Marxists

Encoded within the idea that “entropy means freedom” is an argument against Marxism as dogmatic academic philosophy. It’s not a refutation of dialectical materialism. It’s certainly not a condemnation of popular movements that advocate for land/wealth redistribution, debt forgiveness, educating “the masses”, and any action that truly results in more power to the people. There’s a view here shared between the best market economists and the least dogmatic

socialists that increasing the total amount of wealth is good, that decreasing wealth inequality is also good, that these things might even go hand-in-hand. There's a quiet observation here that true wealth is about much more than physical property.

"Entropy means freedom" is a philosophy of political praxis in the face of both ephemeral and persistent suffering. Human society has always been large beyond comprehension. We have always been exposed to ephemeral human suffering that we can't do much to heal personally, though the television and now the Internet shows us more than usual. There have also always been forms of persistent human suffering, though in our era of colonization and poverty and environmental catastrophe, this takes predictable forms that may have well-defined solutions. We can move towards solutions to both forms of suffering through entropy.

Most critically, we can fight for more free time. I'm talking about shorter working hours, more vacation days, more remote work, increased leeway to goof off in the workplace, all while fighting for even higher wages. The social and moral and philosophical problem is that many more of us believe somewhere deep down that we don't deserve these things. We begin to suspect that most of us are selfish immoral deviants, that without being subjected to arbitrary human authority our lives would be nasty, brutish, and short. This sense of unworthiness is what socialism as a social philosophy is designed to fight.

The wealth tax + universal basic income thus poses both an advance in socialist philosophy and a sharp challenge to socialist dogma. The idea opens up the once vaguely-defined possibility of a disorderly transition from socialism to communism, where the more educated people quickly start to live in communist bliss while many others take a while to let go of the idea of personal property. The idea is so amorphous and ill-defined on the small scale that there's little danger that new dogmas will form around it. The policy has enough well-defined positive impacts on the large scale that it is difficult to criticize either from a dogmatic political perspective or from an apathetic apolitical perspective. It can only be advocated by people who genuinely believe in people power; it will only happen when enough of us realize that we actually deserve it.

Entropy means freedom. This means that free time matters, whether that's free time for high-paid office workers to self-actualize or free time for those imprisoned by a racialized criminal punishment system to self-actualize. Shorter working hours and prison abolition and solving your neighbors' weird tech problems all go hand in hand.

Entropy means freedom. This means that good vibes matter, because good vibes bounce off on other people and helps people form more intimate connections with other human beings. The more genuine and diverse human connections we can make, the weaker this system built around "divide and conquer" becomes.

Entropy means freedom. This means that ending self-repression matters. This means educational liberation, or the total destruction of the idea that you are stupid or incompetent, through the continuous process of teaching and learning things you find cool. This means sexual liberation, or the total destruction of the idea that you are deviant and immoral for seeking sexual pleasure.

Entropy means freedom. This means that self-determination matters, that there must be unity between means and ends. This means recognizing that the only way great people have ever improved the world is by increasing humanity's capacity for self-determination.

All power to the people!

on the ideology of the authors

This is the first post in a trilogy on scientific socialism. Our understanding of the term will be elucidated throughout the series. For now, let's say it's a challenge both to socialism and to science. Sometimes, we think that socialist dogma must be questioned using both the statistical approach of science and the democratic approaches of horizontal organizing. And sometimes, "objective" science must be simplified and subjectified into myth so that new learners have a faster path to deep knowledge. "Entropy means chaos" not only justifies genocidal politics, but also confuses those curious about the actual physics. We even suspect that "entropy means freedom" will contribute to better explanations of entropy in the context of information theory and cryptography, where it can be thought of as the "degrees of freedom" that exists in the information.

Sources:

<https://www.nps.gov/jame/learn/historyculture/african-americans-at-jamestown.htm>

<https://www.britannica.com/summary/Industrial-Revolution-Timeline>

<https://www3.nd.edu/~powers/ame.20231/carnot1897.pdf>

The general sketch of the science explainer came from PBS Space Time's *The Misunderstood Nature of Entropy*. I supplemented the sketch by actually reading Carnot's work and connecting it to a basic theory of industrialism I've been crafting.

I'm not going to reveal the source for the GDP chart. I suspect that it's wrong, because it applies an exponential model back too far. I suspect that the slow rise in global GDP from 1000 to 1500 would be erased if people did deep detective work into the pre-colonial economies of West Africa, Western Europe, and Turtle Island. This would make the sudden exponential of industrialism even more pronounced and my perspective on it irrefutable.

This was written in December of 2021