Arespectfulness:
Invisible Inheritance and the Stack of Solved Impossibilities

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June 2026

Abstract

A reader of this sentence is breathing oxygen made by cyanobacteria, thinking with energy that mitochondria release, and reading marks that took 4,000 years to standardize, and feels none of it. This paper gives that condition a name. Arespect is the failure to register that there was any worth, cost, or difficulty there to begin with, the blankness that settles over a hard-won achievement once it hardens into a reliable interface. It is neither contempt nor ingratitude, both of which require seeing the thing first. The mechanism is stack blindness. A working layer drops out of attention because we look through it to whatever it lets us do, and it comes back into view only when it breaks. The first half of the argument separates arespect from a crowd of near-relations, the disenchantment of Weber, the reification of Lukács, the inattentional blindness of the psychologists, the withdrawing tool of Heidegger, the invisible infrastructure of Star, the black box of Latour, the tacit knowing of Polanyi, and shows that each of these names how a layer drops from view, or what it is that drops, while none names the failure of regard that the dropping makes possible. The second half walks the stack downward, from breathable air and the mitochondrion to fire, writing, and the compiler, and grades its own evidence as it goes, because a paper about the failure to see depth owes the reader an honest account of how deep its claims actually reach and where the floor of the known gives way. What it recommends is not gratitude, which can be performed without seeing anything, but the harder thing gratitude presupposes: looking twice at what one had stopped seeing.

1. The Floor Was a Mountain

It is very hard to feel how hard fire was. The hominin who first kept an ember alive through a cold night was holding a door open against everything that wanted to close it: damp, wind, exhaustion, the simple tendency of a fire left alone to go out. Almost everything that came after, the cooked meal and the forge and the kiln and the furnace that smelts glass, runs on a competence that now sits inert inside a supermarket lighter. The compression repeats at every later layer. Someone who has written a compiler by hand knows that the offhand command to build a program stands on parsing, type theory, register allocation, an instruction set, and a long sediment of failures that taught the field what not to do, and knows just as surely that the next person to type the command will feel none of that weight. The difficulty was real. None of it vanished; it was paid once and folded out of sight, and the folding is the whole achievement.

This is the ordinary condition of anyone living after accumulation. We stand on top of a very tall stack and take the top for the ground. Breath is just breath. Text is just text. A deployment is just a push to production. Under each "just" lies something that was once frightening or sacred or all but impossible, and the burial is no negligence but the mechanics of leverage. A layer earns the right to be forgotten by becoming dependable, and dependability is the property that lifts a thing out of notice. The better it works, the less we see it.

The attitude this breeds toward the stack is what this paper is about, and the available words do not quite catch it. The attitude is not contempt; hardly anyone despises the power grid or the

alphabet or the chemistry of respiration. It is closer to a numbness, an inability to feel the weight of the thing one is standing on. The word I will use for it is arespect: the absence of felt regard for inherited difficulty, absent not because the difficulty has been weighed and dismissed but because it is no longer perceived at all. The condition is arespectfulness; its mechanism, the way a working layer slips out of view, is stack blindness. I will argue that arespect is a distinct and consequential failure of perception, that its shape is the same whether the inherited layer is geological, biological, or technical, and that the failure is manufactured by the success of the thing it concerns, so that respect, where it happens, is something won against the grain rather than a default that decent intentions would supply.

2. A Failure of Regard

Three stances toward an inherited thing can be told apart. Respect sees its worth and its cost and grants it regard. Disrespect sees the worth and works to diminish it; the cynic looks at the cathedral and calls it a shed. Arespect does neither, because nothing has registered as being there to weigh. The decisive break is the second one. Disrespect comes after perception and can be argued with, since a person can be shown that the thing they belittled was worth more than they said. Arespect comes before perception, and argument has nothing to grip, because one cannot revise a valuation one never made. The Latin says as much. To respect, from *respicere*, is to look again. Arespect is the state of never having looked twice, of treating a standing miracle as furniture.

A few distinctions keep the concept honest. It is a disposition rather than a lapse; the claim is not that someone failed to notice the grid this morning but that their whole standing relation to the grid is one of unfelt reliance. It is evaluative without being a charge of bad character. To call a stance arespectful is first of all to say it fails to track something real, the buried labor and solved problems a layer holds, and only after that, if at all, to assign blame. A person can be entirely innocent and thoroughly arespectful at once, which is why arespect is closer to a perceptual deficit than to ingratitude. Gratitude is one possible response to perceived depth; arespect is the prior absence of the perception that would give gratitude, or its refusal, anything to be about. What goes unseen is also specific. The arespectful user of a bridge sees the bridge perfectly well and crosses it without trouble; what does not register is the bridge as an achievement, the ore and the metallurgy and the load calculation and the unglamorous decades of maintenance holding it in the air.

The word has to earn its place against a crowd of near-relations, and the crowd is large. Each of them names something real and adjacent. Each names either the mechanism by which a layer drops from view or the content that drops, and none of them names the failure of regard that the dropping makes possible.

Concept	What it names	How arespect differs
Disenchantment (Weber, 1946)	The cultural draining of mystery from a world made calculable	Removes wonder from the knowable; arespect removes regard for difficulty, and can coexist with full re-enchantment
Reification (Lukács, 1971)	Human relations appearing as relations between things	Misreads the human as thing; arespect fails to perceive the difficulty inside the thing, and persists outside any commodity form
Alienation (Marx, 1959)	The producer's estrangement from their own labor and its product	Concerns the producer's own activity; arespect concerns the beneficiary's relation to others' sedimented labor
Inattentional blindness (Mack & Rock, 1998; Simons & Chabris, 1999)	Failure to perceive an unattended stimulus under load	A momentary, capacity-limited lapse; arespect is a settled disposition that survives full attention
Change blindness (Rensink et al., 1997)	Failure to detect a change across views	A detection failure; arespect is a valuation failure, intact perception with absent regard
Misplaced concreteness (Whitehead, 1925)	Mistaking an abstraction for the concrete reality	Takes the abstract as real; arespect flattens the concrete depth of the real into a frictionless given, the inverse error
Ready-to-hand withdrawal (Heidegger, 1962)	The working tool receding from notice in skilled use	Names the phenomenological mechanism; arespect is the stance that hardens once the receded is taken for empty
Infrastructural invisibility (Star, 1999)	The structural property by which working infrastructure goes unseen	A property of systems; arespect relocates the phenomenon in the disposition of the perceiver
Tacit knowing (Polanyi, 1966)	The structure of attending from subsidiary particulars to a focal whole	Describes a necessary and healthy reliance; arespect is the pathology of mistaking the subsidiary for the nonexistent

Read down the middle column and a pattern shows itself: every entry describes how, or why, a layer leaves awareness, and in almost every case the leaving is necessary, useful, and often a mark of competence. No one could act while attending to every condition of acting. The right-hand column isolates what is left over once all of that is granted, the failure that becomes possible when a useful withdrawal is mistaken for a fact about the world, when "I need not look at this to use it" slides into "there is nothing here worth looking at." That slide is the only thing the new word names. It is why the word is needed. The disposition it picks out is its own thing, set apart from invisibility, withdrawal, black-boxing, inattention, and reification alike, and a vocabulary with no term for it will keep mistaking the vice for one of the harmless mechanisms that make it tempting.

3. Why the Stack Withdraws

The withdrawal that makes arespect possible has been described, independently, from several directions at once, and the agreement among them is worth dwelling on. Heidegger's analysis of equipment in *Being and Time* gives the bare phenomenology. A tool in skilled use is *zuhanden*, ready-to-hand, and its readiness is a kind of self-erasure: the hammer is not a thing one attends to but the means through which attention reaches the work, and the more fluent the use, the more completely the hammer disappears (Heidegger, 1962). It comes back as an object only when it fails. The head flies off, the handle splits, and suddenly there it is, a mere present-at-hand thing with weight and grain and a price, conspicuous in proportion to its uselessness. While it works it is unseen. Breakdown is what returns it to sight.

Susan Leigh Star took the same shape from the hammer to the water main and gave it a sociology. Working infrastructure is embedded, learned as part of belonging to a community, built on top of whatever was already there, and transparent in use, and from those properties comes the one that matters here: it becomes visible on breakdown (Star, 1999; Star & Ruhleder, 1996). The server goes down, the bridge washes out, the power fails, and the substrate no one had been looking at lurches into view, often dragging into view with it the maintenance arrangements that had been holding it up in silence (Bowker & Star, 1999). On this account invisibility is not a flaw in infrastructure but a condition of its working. A road one had to assemble deliberately for each journey would not be a road.

Latour gave the epistemic version of the paradox a sentence hard to improve on. Black-boxing, he wrote, is the way technical work is made invisible by its own success: when a machine runs well, when a fact is settled, you attend only to its inputs and outputs and not to the tangle inside, so that, against all intuition, the more science and technology succeed, the more opaque they become (Latour, 1999). Hold onto that last clause. The opacity is manufactured by success and grows with it, and a better explanation cannot dissolve it, because success is the thing producing it. A technology everyone still understood in detail would be one that had not yet sunk far enough into use to be useful.

Polanyi supplies the cognitive grammar that joins these together, and, more important, marks the line that arespect crosses. In any skilled act, he observed, we attend *from* a set of subsidiary particulars *to* a focal whole. The pianist attends from the keys to the music; the reader attends

from the letters to the sense; and to turn focal attention back onto the particulars, to stare at the individual keys in the middle of a phrase, is to wreck the performance (Polanyi, 1966). We lean on the stack by dwelling inside it, by seeing through it, and this attending-from is how competence works in the first place. The line is right there. A demand that we attend to every inherited layer all the time would be a demand to be paralyzed, and the concept concedes this without flinching. The pathology lies in the further step, the one nothing in the act itself requires, from "I rightly look through this" to "there is nothing here to look at." Watch how short the step is. The listener who hears a flawless performance and concludes that playing must be easy, that there was no decade of practice and no history of instrument-building under the music, has taken it. Respect does not ask the listener to stare at the keys. It asks only that the smoothness not be read as evidence of shallowness.

Two more sources name not the mechanism but its cargo, the thing that drops out. Simondon argued that culture meets technical objects with a built-in blindness to their genesis, treating them either as bare lumps of utility or as menacing robots, and in both cases missing that a technical object is the residue of a long individuation, a slow convergence toward internal coherence he called concretization, with its whole formative history folded inside it (Simondon, 2017). What disappears is precisely that history, the ordered sequence of solved problems that made the object what it is. Stiegler pressed the point into time. The human, on his account, is constituted by pushing memory and experience outward into technical supports, an inheritance he called tertiary retention, and the inheritance reaches each newcomer already finished, with the labor of its making cut away, so that a kind of forgetting is built into the channel by which technics passes down (Stiegler, 1998). The stack, in his terms, is externalized memory, and it arrives stripped of any record of what it cost. That is the deep reason arespect is the default and respect the exception. The mechanisms of withdrawal are everywhere, and the cargo they carry off is, by the manner of its delivery, erased in advance.

4. Breath as Inherited Geology

The stack does not begin with tools. The oldest layers anyone inherits are geological and biological, and they hide their difficulty even more completely than tools do, because they were laid down before anything existed that could be impressed by them. Take the plainest case, the air. The oxygen a reader is burning right now, at a rate the body never puts to a vote, is no neutral backdrop to life on Earth but the leftover of a planetary-scale piece of biological work, and to treat it as simply given is arespect toward an inheritance 2 billion years deep.

Through most of the Archean the atmosphere held almost no free oxygen, below a hundred-thousandth of today's level. Its permanent rise, the Great Oxidation Event, is placed in the early Paleoproterozoic, with onset bracketed around 2.4 to 2.3 billion years ago and the transition trailing well past that, and the rise is read in the rock from the disappearance of a sulfur-isotope signature that can only survive under an oxygen-poor sky (Lyons et al., 2014; Bekker et al., 2004). The agent was oxygenic photosynthesis in cyanobacteria. One feature of the timeline does real work for the argument: the capacity to make oxygen seems to predate its lasting accumulation

by hundreds of millions of years, because the early oxygen was eaten by reduced iron and other sinks in the oceans and crust before it could build in the air (Lyons et al., 2014). The most recent high-resolution work puts the coupled oxygenation of air and ocean nearer 2.3 billion years and stresses how halting and drawn-out the transition was (Ostrander et al., 2024). The exact onset is still argued over across a wide window. The breath should be dated as the slow outcome of a planetary process, never as a moment.

To the life already present, the change was a chemical assault. Molecular oxygen and the reactive species it spins off attack iron-sulfur clusters, iron centers, and DNA, and the chemistry of that damage is understood down to the mechanism (Imlay, 2003; Imlay, 2013). The answer evolution found was a standing apparatus of defense, the superoxide dismutases and catalases and peroxidases that aerobic life runs without pause, so that the inheritance now keeping us alive had first to be survived. Here a restraint the rest of this paper will keep becomes necessary, because the usual telling overreaches. There is no direct evidence for a discrete mass extinction of the anaerobes, an "oxygen catastrophe" in the sense of a documented die-off, and the microbial record of the period is far too thin to carry such a claim. What the evidence supports is narrower and still dramatic: rising oxygen bore down as a hard selective pressure, drove the evolution of the antioxidant machinery, and pushed the obligate anaerobes into the airless refuges where they live to this day (Sessions et al., 2009). Oxygen was at once a poison to be defended against and a richer energy source than anything before it, the basis of an aerobic metabolism many times more efficient than fermentation. Both things were true together, which is most of why the planet was remade.

The chronology runs back past the air itself. The last universal common ancestor, the cellular population from which everything alive descends, is reconstructed as an anaerobe, and that much is bedrock, settled twice over by the plain fact that the early Earth offered no free oxygen to use. The most influential reconstruction goes much further, reading from a set of genes traceable to that node a hydrogen-dependent, carbon-fixing metabolism rooted at a hydrothermal vent (Weiss et al., 2016). Here the restraint has to reassert itself, because that fuller portrait is a strong inference and not a settled fact, exposed to undetected lateral gene transfer and revised by later work that moves the organism's age and gene count (Moody et al., 2024). The safe claim is the spare one. The ancestor was anaerobic, and the oxygen world its descendants now take for the obvious home of life would have been alien to it, and most likely lethal. The breath is borrowed biochemistry, paid for across deep time by organisms that could have meant us nothing.

5. The Engine in the Cell

Between the oxygen in the air and the thought that turns to consider it sits a third inherited layer, the one that turns the first into the second. Aerobic eukaryotic life runs on mitochondria, and their origin is among the few deep-evolutionary facts firm enough to lean on. The mitochondrion descends from a free-living alphaproteobacterium taken inside an archaeal host in a single act of endosymbiosis, an idea Lynn Margulis revived in the nineteen-sixties and that phylogenomics has since put past serious doubt (Margulis, 1967; Muñoz-Gómez et al., 2022). What is still argued is the order of events: whether swallowing the bacterium triggered the complex cell or merely

punctuated a lineage already on its way to complexity. The hydrogen hypothesis, the discovery of the Asgard archaea as the nearest prokaryotic kin of eukaryotes, and the laboratory cultivation of a syntrophic Asgard archaeon all bear on the question without closing it (Martin & Müller, 1998; Spang et al., 2015; Imachi et al., 2020). The inheritance is certain. Its founding moment is still being reconstructed.

How the mitochondrion makes energy was settled by a discovery that overturned a decade of consensus and now stands as firm as anything in the cell. Peter Mitchell's chemiosmotic hypothesis held that the respiratory chain pumps protons across the inner membrane to build an electrochemical gradient, a proton-motive force, and that the gradient drives the synthesis of ATP, the currency the cell spends on everything (Mitchell, 1961). The inner membrane folds into cristae, and the folding does work rather than decoration: cristae shape, set by a dedicated protein machinery and by rows of ATP-synthase dimers that crimp the membrane along their ridges, organizes the respiratory chain and tunes how efficiently energy is converted (Cogliati et al., 2013; Cogliati et al., 2016). A surprising amount of what lets a thought happen at all is settled here, in the geometry of a membrane almost no thinker will ever picture.

A famous and elegant argument tries to make the mitochondrion the cause of complex life itself, and honesty requires it be reported as the open dispute it is. Lane and Martin proposed that prokaryotes run into a bioenergetic ceiling, because they make ATP across their outer surface and scaling up the cell yields less and less return, and that the mitochondrion broke the ceiling by bringing the energy-converting membranes inside, each with its own small genome, so supplying orders of magnitude more energy per gene and clearing the way for the genome and the complexity that eukaryotes carry (Lane & Martin, 2010). The mechanism is plausible and the picture is seductive. The central number has also been challenged head-on: Lynch and Marinov recomputed the energetic cost of a gene against cell volume across both domains and found no decisive mitochondrial advantage, since eukaryotes gave up surface bioenergetics in the bargain (Lynch & Marinov, 2015), and others have doubted the whole energy-first framing of how the complex cell arose (Booth & Doolittle, 2015). So the proposition that mitochondria made complexity possible stays an open hypothesis, and it cannot be used here as anything more.

The version of the inheritance the evidence will actually bear runs through cognition by way of energy budgets rather than grand causation. The brain is metabolically extravagant. It is about 2% of body mass and burns on the order of 20% of the body's resting energy, and that share holds remarkably steady whether the mind is working hard or idling (Raichle & Gusnard, 2002). Most of the spend is not upkeep but signaling, the electrochemical work of firing nerve impulses and then resetting the ion gradients each impulse spends, with the careful budgets assigning the largest share of grey-matter energy to action potentials and to the currents at synapses (Attwell & Laughlin, 2001; Harris et al., 2012). That work falls to ATP-driven pumps, and at the synapse the ATP comes from mitochondria, which are hauled out to the presynaptic terminals to supply it and to soak up calcium, and whose local reserves are needed for the protein synthesis that makes synaptic change stick (Devine & Kittler, 2018; Rangaraju et al., 2019). The same relentless demand is why neurons are so exposed when the machinery falters, which is why failing mitochondria turn up again and

again in neurodegeneration, and why chronic stress leaves a mark on mitochondrial state, though which way the causation runs in disease is not yet clear (Picard & McEwen, 2018).

So this much can be said, and only this much. Cognition rests on a bioenergetic infrastructure; mitochondrial ATP and calcium handling are conditions without which neural computation degrades. What the evidence does not license is the seductive next step, the claim that the fold of a crista or the flux of a proton produces or explains conscious experience. The researchers who take brain energetics most seriously say as much themselves, describing energy as a precondition for consciousness rather than a correlate of it and leaving the explanatory work to theories of neural integration (Chen & Zhang, 2021). One confusion has to be flagged, because the words invite it. The "free energy" of the free-energy principle in theoretical neuroscience is an information-theoretic quantity, a measure of surprise against a model, and has nothing directly to do with the metabolic free energy a mitochondrion supplies (Friston, 2010); to glide between the two senses is a category error wearing the costume of a discovery. The honest seam is interoception, the brain's own sense of the body's physiological state, which sits close to the regulation of metabolism and is a candidate ground for the felt sense of being a living body (Craig, 2002; Barrett & Simmons, 2015), and which deserves to be treated as the open frontier it is and not as a bridge already crossed. The subject who says "I think" does so on top of an energy infrastructure it did not build and cannot switch off. That sentence is true and worth feeling. The sentence that would have a crista do the thinking is not licensed, and keeping the two apart is the whole of the restraint.

6. Fire and the Externalized Mind

Above the biological layers the human stack proper begins, and it repeats the figure in a register that can, at least in principle, be dug up and dated. Fire is the hinge. Cooking moved digestion partly outside the body: heat gelatinizes starch, unfolds protein, and kills what would otherwise sicken the eater, so that more energy comes out of food for less spent getting it, and on the cooking hypothesis this windfall is what let the human brain, the expensive organ of the section before, grow while the gut shrank to pay for it (Wrangham, 2009; Wrangham et al., 1999; Aiello & Wheeler, 1995). The hypothesis is powerful and it is contested at the joint it most needs, the timing, and the better course is to say so rather than smooth it over. Secure traces of controlled fire are old but scattered, burned bone and ashed plant matter at Wonderwerk Cave near 1 million years ago, a hearth-bearing site at Gesher Benot Ya'aqov around 790,000 (Berna et al., 2012; Goren-Inbar et al., 2004), and yet the evidence for *habitual* fire, fire dependable enough to build an evolutionary dependency on, only turns continuous much later, perhaps 400,000 to 300,000 years ago, which leaves the cooking hypothesis straining against its own clock (Roebroeks & Villa, 2011). The strict brain-versus-gut trade-off has been loosened too, by work finding no simple inverse between brain size and digestive-tissue size across the primates (Navarrete et al., 2011). What survives all of this is the structural claim, and it is enough: a metabolic feat was pushed out into a technique, the technique became a precondition for the kind of animal that uses it, and the precondition now hides inside the wholly unremarkable act of eating something cooked.

Writing pushed memory outside the skull, and it did so first as bookkeeping. The earliest writing

in the Mesopotamian line grew out of small clay tokens for counting goods, the tokens giving way to marks pressed into clay and then to cuneiform, so that the medium later trusted with scripture and law began as a way to track debt and grain (Schmandt-Besserat, 1992). What it bought, on the strong reading from the study of orality and literacy, was memory placed outside the body, durable, carried across distance and death, and laid open to the kind of inspection a list or a contract or a table allows (Ong, 1982; Goody, 1977; Goody & Watt, 1963). The bolder claim, that literacy reshaped the form of thought itself and split the literate mind from the oral one along a clean line, is a live dispute and should be named as one, since the so-called Great Divide has been hard pressed by the argument that literacy's effects belong to the particular social practices that convey it and are not uniform consequences of the technology (Street, 1984).

The sharpest thing ever said about writing is also the oldest, and it is very nearly a definition of arespect caught in the act. In Plato's *Phaedrus* the god Theuth offers writing to the king as a cure for forgetting, and the king answers that it is the reverse, a recipe for forgetting rather than for memory, since those who learn it will trust the outside marks and stop remembering from within (Plato, 1995). The complaint is itself an instance of the thing this paper is about, a flash of vivid perception of a layer in the moment it is installed, before it sinks out of sight. 24 centuries on, the alphabet is so completely inherited, so wholly a thing looked through and not at, that the reader of this line passes from the letters to the meaning without a trace of the abstraction phonetic writing demanded. The king's forgetting arrived exactly on time.

That no one person could rebuild this stack is not a flourish but a finding. Human capability is the output of a ratchet, a cultural transmission faithful enough to keep improvements and so to stack them across generations far beyond what any single mind could invent (Tomasello, 1999), and the dependence this creates is total, as its failures show with brutal clarity. Well-supplied explorers have starved in country that fed the people native to it, because surviving there ran on a deep body of local know-how, which plants must be leached of their poison and how, that the explorers did not carry and could not derive from scratch in the time they had (Henrich, 2016). The know-how was a stack, inherited by the locals and as invisible to them as a stack as anyone's is, and fatal in its absence. None of this is a failure of intelligence. The explorers were clever and they died anyway, arespectful in the sense that they could not feel the depth of an inherited competence until its absence killed them.

7. The Designed Black Box

Computing is where the stack turns self-aware, because here the burial of difficulty under an interface is not a side effect of success but a stated goal, pursued under its own name. The history that the idle command to compile a program hides is recent enough to be documented and dramatic enough to make the compression visible. When Grace Hopper built the first compiling systems at the start of the nineteen-fifties, the idea that a machine could translate human-readable instructions into its own code was met with flat disbelief, on the assumption that programming was a clerical arithmetic the computer could not be trusted to do on its own behalf (Hopper, 1952). When the FORTRAN team a few years later shipped a compiler whose output held its own against hand-

written assembly, it did so against a settled conviction that automatic translation would always be too wasteful to use (Backus et al., 1957). The conviction was reasonable and wrong, and its defeat laid down a layer. Every programmer since inherits the compiler as a given and feels nothing of the doubt that had to be beaten to build it.

What sets the technical stack apart is that its opacity is engineered on purpose, and the engineering has a literature. Dijkstra answered the charge that abstraction is a kind of vagueness by turning it inside out: the point of an abstraction, he wrote, is not to be vague but to create a new level of meaning at which one can be wholly exact, a level one can reason on without dropping into the one below (Dijkstra, 1972). Parnas made the same idea a discipline of design under the name information hiding, the deliberate sealing of a module's internals behind an interface so the rest of the system can use it without knowing, and without being able to rely on, how it works inside (Parnas, 1972). Information hiding is stack blindness written into a specification; the inability to see in is the feature on the order sheet. Simon had supplied the general rationale a decade earlier, observing that complex systems tend to be hierarchic and nearly decomposable, built from layered subsystems whose internal dealings are dense and whose dealings across layers are sparse, and pointing the moral with a parable of two watchmakers, the one who builds in stable sub-assemblies finishing while the one who must hold the whole mechanism at once never does (Simon, 1962). To build anything complex is to build it in layers, and to build in layers is to build in places no one will look.

So the technical stack mirrors the biological one, with a single difference worth stating outright: the compiler was designed to hide what it does, and the mitochondrion was designed by nothing at all. For the user the result is the same, a dependable interface looked through rather than at, and the engineered case has the advantage of showing the breakdown-reveals-the-stack figure under laboratory control. The practitioner's law of leaky abstractions records it: every non-trivial abstraction leaks, and the substrate it was built to hide pushes back through at the edges, in the performance cliff or the baffling error that drives the programmer down a level to face what the abstraction had been keeping off the desk (Spolsky, 2002). The leak is the engineered twin of Heidegger's broken hammer and Star's dead server, the instant the black box springs and shows, briefly and unwelcomely, what is in it. The hard core of a problem persists under the conveniences piled over it, a line the field itself has long drawn between the complexity that belongs to a problem and the complexity merely heaped on by poor tools (Brooks, 1987). Artificial intelligence is the newest layer of the kind, a statistical compression of a vast quantity of inherited human culture into something one can call with a sentence, and it breeds an especially pure arespect, since the user attends to a fluent reply while the training corpus, the human labor inside it, and the machinery doing the compressing all fall away, a black box now opaque even to the people who built it.

8. What the Evidence Will Bear

A paper about the failure to perceive depth takes on an unusual obligation: to perceive the depth of its own claims accurately, the shallow stretches included. The cure it prescribes is to see clearly where the floor of the known actually lies, and that means marking, claim by claim, how far each

one reaches and the overreach the careful version declines. The empirical load is not evenly strong, and the table below grades it.

Claim used in the argument	Status	Key sources	Overclaim the paper refuses
Breathable oxygen is the accumulated product of cyanobacterial photosynthesis, risen permanently around 2.4 to 2.3 Ga	Established as to cause; the precise onset is contested across a wide window	Lyons et al. (2014); Bekker et al. (2004); Ostrander et al. (2024)	That the rise was a single datable event rather than a protracted transition
Rising oxygen chemically threatened anaerobic life and selected for antioxidant defenses	Mechanism established; the scale of any die-off is not	Imlay (2003, 2013); Sessions et al. (2009)	That the event was a documented mass extinction, an "oxygen catastrophe"
LUCA was anaerobic	Bedrock, over-determined by an anoxic early Earth	Weiss et al. (2016); Moody et al. (2024)	That its hydrothermal, hydrogen-dependent metabolism is settled fact
Mitochondria arose once by endosymbiosis of an alphaproteobacterium	Established	Margulis (1967); Muñoz-Gómez et al. (2022)	That the early-versus-late timing of the event is resolved
ATP synthesis proceeds by chemiosmosis across folded cristae	Established	Mitchell (1961); Cogliati et al. (2013, 2016)	That cristae geometry has any settled relation to conscious experience
Mitochondria removed a bioenergetic ceiling and so enabled eukaryotic complexity	Live controversy	Lane & Martin (2010) versus Lynch & Marinov (2015); Booth & Doolittle (2015)	That the energy-per-gene thesis is established; it must be paired with its rebuttal
Cognition depends on mitochondrial ATP and calcium handling as enabling conditions	Established as enabling-condition	Attwell & Laughlin (2001); Rangaraju et al. (2019); Devine & Kittler (2018)	That bioenergetics constitutes or produces consciousness

Claim used in the argument	Status	Key sources	Overclaim the paper refuses
Cooking externalized digestion and helped permit brain expansion	Plausible inference; the timing is contested	Wrangham (2009); Aiello & Wheeler (1995) versus Roebroeks & Villa (2011); Navarrete et al. (2011)	That habitual fire is securely old enough to have driven the expansion
Writing externalized memory and began as accounting	Established	Schmandt-Besserat (1992); Ong (1982)	That literacy uniformly restructures consciousness along a Great Divide

The table is the argument practicing what it preaches, an instance of the looking-twice the paper asks for rather than an apology bolted to its end. And the structural claim, that inherited difficulty drops from perception and that the dropping is manufactured by the success of what drops, does not lean on any one contested fact, because the secure layers show it as plainly as the disputed ones. A reader unconvinced that mitochondria caused complex life can throw that claim out and lose nothing here, since the chemiosmotic machinery is no less an unfelt inheritance for the quarrel over what it made possible. This is also the answer to the suspicion that the biology is doing rhetorical work it cannot support. The argument is pinned to the enabling-condition claim, which is solid, and it refuses by name the constitutive claim that would seat the mind in a membrane; the contested propositions are flagged as contested and bear no weight the argument needs. A paper diagnosing overreach that itself overreached would refute itself, so the restraint is not a fence around the argument but a piece of it. To see the stack truly is, among other things, to see how much of it is still genuinely unknown, and a respect that waited for the depths to be fully charted would be sentiment rather than sight.

9. Accumulated Impossibility

The figure has held at every scale the argument has touched. Some difficult thing, the oxygenation of a planet, the capture of a bacterium that became a power plant, the keeping of fire, the export of memory into clay, the translation of language into machine behavior, hardens into a dependable layer; the layer is looked through and not at; the looking-through, which is proper and even required, sets into the conviction that there is nothing underneath; and the achievement passes to the next inheritor as a frictionless given they feel nothing of. Civilization read this way is accumulated impossibility made usable, a tower of solved problems each buried under the interface that solving it produced, and arespect is the standing relation of those who live near the top to the depth they stand on.

That relation has a cost, and it is not only a contemplative one. The same blindness that hides a

layer's genesis hides the people who keep the layer standing. Those who repair and maintain the infrastructure work inside a structural invisibility the cult of the new only deepens, their effort unseen because success is silent and only failure speaks (Russell & Vinsel, 2016; Vinsel & Russell, 2020). A use-centered rather than novelty-centered history of technology shows the scale of the omission, since maintenance consumes far more of the world's technical effort than invention does while drawing almost none of its attention (Edgerton, 2007). Arespect toward the stack runs continuous, then, with arespect toward the people who hold it up, and learning to see the bridge as a sustained achievement is also learning to see the crews who sustain it.

What the argument asks for is not gratitude, which can be staged without seeing anything, and not a paralyzed reverence that would have one stare at the keys mid-phrase. There is no unmediated ground to retreat to in any case; since the human is made by its technical inheritance, the only choice on offer is between meeting that inheritance with regard and meeting it without (Stiegler, 1998). What is left is the harder and quieter thing: to know that the floor was once a mountain while still walking across it without effort, to look through the stack and keep its depth in view at the same time. That is the literal sense of the word, *respicere*, to look again, and the looking-again has to be won against the whole momentum of inheritance, since the stack is built at every layer to make itself unnecessary to see. The hominin with the ember could still feel what fire cost. To recover some part of that feeling, deliberately, against the grain, is to remember that the breath is on loan from cyanobacteria, that the thought is paid for in proton gradients, that these very words are an externalized memory the king of Egypt did not trust, and that under the most ordinary act of an ordinary day lies a difficulty that someone, or some lineage, or some planet, once had to survive.

References

Aiello, L. C., & Wheeler, P. (1995). The expensive-tissue hypothesis: The brain and the digestive system in human and primate evolution. *Current Anthropology*, 36(2), 199-221.

Attwell, D., & Laughlin, S. B. (2001). An energy budget for signaling in the grey matter of the brain. *Journal of Cerebral Blood Flow & Metabolism*, 21(10), 1133-1145.

Backus, J. W., Beeber, R. J., Best, S., Goldberg, R., Haibt, L. M., Herrick, H. L., Nelson, R. A., Sayre, D., Sheridan, P. B., Stern, H., Ziller, I., Hughes, R. A., & Nutt, R. (1957). The FORTRAN automatic coding system. In *Proceedings of the Western Joint Computer Conference* (pp. 188-198). Institute of Radio Engineers.

Barrett, L. F., & Simmons, W. K. (2015). Interoceptive predictions in the brain. *Nature Reviews Neuroscience*, 16(7), 419-429.

Bekker, A., Holland, H. D., Wang, P.-L., Rumble, D., Stein, H. J., Hannah, J. L., Coetzee, L. L., & Beukes, N. J. (2004). Dating the rise of atmospheric oxygen. *Nature*, 427(6970), 117-120.

Berna, F., Goldberg, P., Horwitz, L. K., Brink, J., Holt, S., Bamford, M., & Chazan, M. (2012). Microstratigraphic evidence of in situ fire in the Acheulean strata of Wonderwerk Cave, Northern

Cape province, South Africa. *Proceedings of the National Academy of Sciences*, 109(20), E1215-E1220.

Booth, A., & Doolittle, W. F. (2015). Eukaryogenesis, how special really? *Proceedings of the National Academy of Sciences*, 112(33), 10278-10285.

Bowker, G. C., & Star, S. L. (1999). *Sorting Things Out: Classification and Its Consequences*. MIT Press.

Brooks, F. P. (1987). No silver bullet: Essence and accidents of software engineering. *Computer*, 20(4), 10-19.

Chen, Y., & Zhang, J. (2021). How energy supports our brain to yield consciousness: Insights from neuroimaging based on the neuroenergetics hypothesis. *Frontiers in Systems Neuroscience*, 15, 648860.

Cogliati, S., Enriquez, J. A., & Scorrano, L. (2016). Mitochondrial cristae: Where beauty meets functionality. *Trends in Biochemical Sciences*, 41(3), 261-273.

Cogliati, S., Frezza, C., Soriano, M. E., Varanita, T., Quintana-Cabrera, R., Corrado, M., Cipolat, S., Costa, V., Casarin, A., Gomes, L. C., Perales-Clemente, E., Salviati, L., Fernandez-Silva, P., Enriquez, J. A., & Scorrano, L. (2013). Mitochondrial cristae shape determines respiratory chain supercomplexes assembly and respiratory efficiency. *Cell*, 155(1), 160-171.

Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. *Nature Reviews Neuroscience*, 3(8), 655-666.

Devine, M. J., & Kittler, J. T. (2018). Mitochondria at the neuronal presynapse in health and disease. *Nature Reviews Neuroscience*, 19(2), 63-80.

Dijkstra, E. W. (1972). The humble programmer. *Communications of the ACM*, 15(10), 859-866.

Edgerton, D. (2007). *The Shock of the Old: Technology and Global History since 1900*. Oxford University Press.

Friston, K. (2010). The free-energy principle: A unified brain theory? *Nature Reviews Neuroscience*, 11(2), 127-138.

Goody, J. (1977). *The Domestication of the Savage Mind*. Cambridge University Press.

Goody, J., & Watt, I. (1963). The consequences of literacy. *Comparative Studies in Society and History*, 5(3), 304-345.

Goren-Inbar, N., Alperson, N., Kislev, M. E., Simchoni, O., Melamed, Y., Ben-Nun, A., & Werker, E. (2004). Evidence of hominin control of fire at Gesher Benot Ya'aqov, Israel. *Science*, 304(5671), 725-727.

Harris, J. J., Jolivet, R., & Attwell, D. (2012). Synaptic energy use and supply. *Neuron*, 75(5), 762-777.

Heidegger, M. (1962). *Being and Time* (J. Macquarrie & E. Robinson, Trans.). Harper & Row. (Original work published 1927)

Henrich, J. (2016). *The Secret of Our Success: How Culture Is Driving Human Evolution, Domesticating Our Species, and Making Us Smarter*. Princeton University Press.

Hopper, G. M. (1952). The education of a computer. In *Proceedings of the 1952 ACM National Meeting (Pittsburgh)* (pp. 243-249). Association for Computing Machinery.

Imachi, H., Nobu, M. K., Nakahara, N., Morono, Y., Ogawara, M., Takaki, Y., Takano, Y., Uematsu, K., Ikuta, T., Ito, M., Matsui, Y., Miyazaki, M., Murata, K., Saito, Y., Sakai, S., Song, C., Tasumi, E., Yamanaka, Y., Yamaguchi, T., … Takai, K. (2020). Isolation of an archaeon at the prokaryote-eukaryote interface. *Nature*, 577(7791), 519-525.

Imlay, J. A. (2003). Pathways of oxidative damage. *Annual Review of Microbiology*, 57, 395-418.

Imlay, J. A. (2013). The molecular mechanisms and physiological consequences of oxidative stress: Lessons from a model bacterium. *Nature Reviews Microbiology*, 11(7), 443-454.

Lane, N., & Martin, W. (2010). The energetics of genome complexity. *Nature*, 467(7318), 929-934.

Latour, B. (1999). *Pandora's Hope: Essays on the Reality of Science Studies*. Harvard University Press.

Lukács, G. (1971). *History and Class Consciousness: Studies in Marxist Dialectics* (R. Livingstone, Trans.). MIT Press. (Original work published 1923)

Lynch, M., & Marinov, G. K. (2015). The bioenergetic costs of a gene. *Proceedings of the National Academy of Sciences*, 112(51), 15690-15695.

Lyons, T. W., Reinhard, C. T., & Planavsky, N. J. (2014). The rise of oxygen in Earth's early ocean and atmosphere. *Nature*, 506(7488), 307-315.

Mack, A., & Rock, I. (1998). *Inattentional Blindness*. MIT Press.

Margulis, L. (1967). On the origin of mitosing cells. *Journal of Theoretical Biology*, 14(3), 225-274. (Published under the name L. Sagan.)

Martin, W., & Müller, M. (1998). The hydrogen hypothesis for the first eukaryote. *Nature*, 392(6671), 37-41.

Marx, K. (1959). *Economic and Philosophic Manuscripts of 1844* (M. Milligan, Trans.). Progress Publishers. (Original work written 1844)

Mitchell, P. (1961). Coupling of phosphorylation to electron and hydrogen transfer by a chemi-osmotic type of mechanism. *Nature*, 191(4784), 144-148.

Moody, E. R. R., Álvarez-Carretero, S., Mahendrarajah, T. A., Clark, J. W., Betts, H. C., Dombrowski, N., Szánthó, L. L., Boyle, R. A., Daines, S., Chen, X., Lane, N., Yang, Z., Shields, G. A., Tamuri, A. A., Williams, T. A., & Donoghue, P. C. J. (2024). The nature of the last universal common ancestor and its impact on the early Earth system. *Nature Ecology & Evolution*, 8(9), 1654-1666.

Muñoz-Gómez, S. A., Susko, E., Williamson, K., Eme, L., Slamovits, C. H., Moreira, D., López-García, P., & Roger, A. J. (2022). Site-and-branch-heterogeneous analyses of an expanded dataset

favour mitochondria as sister to known Alphaproteobacteria. *Nature Ecology & Evolution*, 6(3), 253-262.

Navarrete, A., van Schaik, C. P., & Isler, K. (2011). Energetics and the evolution of human brain size. *Nature*, 480(7375), 91-93.

Ong, W. J. (1982). *Orality and Literacy: The Technologizing of the Word*. Methuen.

Ostrander, C. M., Heard, A. W., Shu, Y., Bekker, A., Poulton, S. W., Olesen, K. P., & Nielsen, S. G. (2024). Onset of coupled atmosphere-ocean oxygenation 2.3 billion years ago. *Nature*, 631(8020), 335-339.

Parnas, D. L. (1972). On the criteria to be used in decomposing systems into modules. *Communications of the ACM*, 15(12), 1053-1058.

Picard, M., & McEwen, B. S. (2018). Psychological stress and mitochondria: A systematic review. *Psychosomatic Medicine*, 80(2), 141-153.

Plato. (1995). *Phaedrus* (A. Nehamas & P. Woodruff, Trans.). Hackett. (Original work ca. 370 BCE)

Polanyi, M. (1966). *The Tacit Dimension*. Doubleday.

Raichle, M. E., & Gusnard, D. A. (2002). Appraising the brain's energy budget. *Proceedings of the National Academy of Sciences*, 99(16), 10237-10239.

Rangaraju, V., Lauterbach, M., & Schuman, E. M. (2019). Spatially stable mitochondrial compartments fuel local translation during plasticity. *Cell*, 176(1-2), 73-84.

Rensink, R. A., O'Regan, J. K., & Clark, J. J. (1997). To see or not to see: The need for attention to perceive changes in scenes. *Psychological Science*, 8(5), 368-373.

Roebroeks, W., & Villa, P. (2011). On the earliest evidence for habitual use of fire in Europe. *Proceedings of the National Academy of Sciences*, 108(13), 5209-5214.

Russell, A. L., & Vinsel, L. (2016, April 7). Hail the maintainers. *Aeon*.

Schmandt-Besserat, D. (1992). *Before Writing, Volume I: From Counting to Cuneiform*. University of Texas Press.

Sessions, A. L., Doughty, D. M., Welander, P. V., Summons, R. E., & Newman, D. K. (2009). The continuing puzzle of the Great Oxidation Event. *Current Biology*, 19(14), R567-R574.

Simon, H. A. (1962). The architecture of complexity. *Proceedings of the American Philosophical Society*, 106(6), 467-482.

Simondon, G. (2017). *On the Mode of Existence of Technical Objects* (C. Malaspina & J. Rogove, Trans.). Univocal. (Original work published 1958)

Simons, D. J., & Chabris, C. F. (1999). Gorillas in our midst: Sustained inattentional blindness for dynamic events. *Perception*, 28(9), 1059-1074.

Spang, A., Saw, J. H., Jørgensen, S. L., Zaremba-Niedzwiedzka, K., Martijn, J., Lind, A. E., van Eijk, R., Schleper, C., Guy, L., & Ettema, T. J. G. (2015). Complex archaea that bridge the eukaryotic and prokaryotic divide. *Nature*, 521(7551), 173-179.

Spolsky, J. (2002, November 11). The law of leaky abstractions. *Joel on Software*.

Star, S. L. (1999). The ethnography of infrastructure. *American Behavioral Scientist*, 43(3), 377-391.

Star, S. L., & Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information Systems Research*, 7(1), 111-134.

Stiegler, B. (1998). *Technics and Time, 1: The Fault of Epimetheus* (R. Beardsworth & G. Collins, Trans.). Stanford University Press. (Original work published 1994)

Street, B. V. (1984). *Literacy in Theory and Practice*. Cambridge University Press.

Tomasello, M. (1999). *The Cultural Origins of Human Cognition*. Harvard University Press.

Vinsel, L., & Russell, A. L. (2020). *The Innovation Delusion: How Our Obsession with the New Has Disrupted the Work That Matters Most*. Currency.

Weber, M. (1946). Science as a vocation. In H. H. Gerth & C. W. Mills (Eds. & Trans.), *From Max Weber: Essays in Sociology* (pp. 129-156). Oxford University Press. (Original work published 1919)

Weiss, M. C., Sousa, F. L., Mrnjavac, N., Neukirchen, S., Roettger, M., Nelson-Sathi, S., & Martin, W. F. (2016). The physiology and habitat of the last universal common ancestor. *Nature Microbiology*, 1(9), 16116.

Whitehead, A. N. (1925). *Science and the Modern World*. Macmillan.

Wrangham, R. (2009). *Catching Fire: How Cooking Made Us Human*. Basic Books.

Wrangham, R. W., Jones, J. H., Laden, G., Pilbeam, D., & Conklin-Brittain, N. (1999). The raw and the stolen: Cooking and the ecology of human origins. *Current Anthropology*, 40(5), 567-594.