

The Final Cause of Cosmic Development: Divine Spirit, or the Second Law of Thermodynamics?

Michael E. Zimmerman
University of Colorado at Boulder
michaelz@colorado.edu

Who knows, perhaps *telos*, perhaps Eros, moves the entire Kosmos, and God may indeed be an all-embracing chaotic Attractor, acting, as Whitehead said, throughout the world by gentle persuasion toward love.ⁱ

Ken Wilber (2000)

Evolution... is the Universe's devious route to its own negation.ⁱⁱ

Stanley N. Salthe (2004)

So, we are in a world that, in effect, does not want to be—a world of massive objects that destroy and replace each other incessantly in a perpetual dance of Shiva.ⁱⁱⁱ

Stanley N. Salthe (2005)

An important function of integral theory is to provide a coherent narrative of cosmic, terrestrial, and human development. Ideally, such a narrative is informed by multiple perspectives, including artistic, spiritual, ethical, scientific, and political. We should assess such narratives in regard to their comprehensiveness, their capacity to orient in a time of confusion, their ability to inspire commitment to a workable future, and their willingness to accept with equanimity the fact that things often do not turn out the way we would prefer. In the past two decades, many useful cosmic narratives have appeared, some more integrative than others.^{iv} In this essay, I will examine another cosmic narrative, this one constructed by a remarkably well-informed integral thinker, Stanley N. Salthe, *emeritus* professor of evolutionary biology at City University of New York.

Salthe's views are largely unknown in integral circles, because he has published primarily in technical scientific journals and monographs. Still, he is well informed about art, music, literature, poetry, religion, philosophy, and other domains pertinent to an integral approach. I first encountered his work five years ago, when researching *Integral Ecology*, a book that I co-authored with Sean Esbjörn-Hargens. Approaching Salthe's research from an integral standpoint, I was struck by how his ideas so often dovetailed with those of Wilber. (In

this essay, I assume readers have some familiarity with Wilber's integral perspective.) In addition to having made significant contributions to hierarchy theory, which has much in common with Wilber's discourse about holons and holarchy, Salthe contends that hierarchy can model a developmental trajectory, from the physical to the biological to the mental. Moreover, Salthe adheres to pan-semiotics and possibly pan-experientialism, because he believes that antecedents for human consciousness must already be present at the lowest integrative level, the physical. That Salthe arrived independently at ideas that overlap with such crucial aspects of the AQAL matrix reinforced for me the conceptual value of that matrix.

Salthe calls his narrative a cosmic myth, the centerpiece of which is the Second Law of Thermodynamics, defined as a universal cosmic attractor that draws all organized form toward dissolution, or entropy. In a startling move, Salthe—along with a number of his contemporaries-- adds that the Second Law not only generates entropy, but also gives rise to forms that assist in the entropy-generating process. Indeed, according to Salthe, the Second Law is the final cause of form in the universe! As forms develop and thus become more complex, they acquire other final causes, but forms will always be to some extent entrained by the Second Law's behest to dissolve other instances of form—including all possible instances of organized energy. The idea that the Second Law is the final cause of form contrasts with views of a number of other integral thinkers, who suggest that divine Spirit, or cosmic Eros, is the final cause—the primal attractor-- of form in the universe. Consider these remarks by Wilber:

Uncreated Spirit, the causal unmanifest, is the nature and condition, the source and support, of this and every moment of evolution. [...]

As the utterly Formless, it does not enter the stream of form at any point. And yet, as Ramana [Maharshi] said, there is a sense in which it is indeed the *summum bonum*, the ultimate Omega Point. [SES, 323] [...]

Despite initial appearances to the contrary, as we shall see, Salthe and Wilber turn out to agree in many respects about the final *causes* at work in cosmic development. In a universe characterized by the polarity of creation and destruction, one form gives way to and devours the next, in the quest for fulfillment that can never be completely attained in the world of form. Salthe adds that such fulfillment is impossible because increasing specification means decreasing flexibility.^v Both thinkers recognize that the universe is awash in *samsara*, the ceaseless round of birth and death in the realm of matter and form. Salthe and Wilber also agree

that contemplative practices allow for liberation from the ceaseless striving *to be* as well as from the yearning *not to be*, whether those yearnings are entrained by the Second Law, or by nondual Spirit. In their forceful cosmic myths, Salthe and Wilber—each in his own way—recommends that while we put forth our best effort to creating a world that limits suffering, we ought not be attached to the fruits of such efforts. In the end, however, Salthe and Wilber differ about certain important matters.

The audience for Salthe’s cosmic myth

Calling on Aristotle’s philosophy, as well as the work of certain 19th century philosophers and scientists, Salthe has revitalized natural philosophy by constructing an integral vision of Nature and its development. Influenced by postmodern epistemology, he states that for him Nature does not mean an unmediated totality of matter, energy, and form “out there” and thus independent of us. Instead, Nature refers to what shows up through the models, theories, framings, and experiments generated by *observers*. Developing a scientifically- and philosophically-informed cosmic myth, which focuses primarily on middle-scale phenomena pertinent and accessible to humans, Salthe proposes both to explain why complex systems (including humans) puts on such constant displays of creation and destruction, and to recommend how humankind might resist the pull to continue such displays, which are making the biosphere increasingly unsuitable for human life.

Salthe has made a name for himself in the scientific community not only by his work in hierarchy theory, but also in evolutionary theory, the standard version of which he has strongly criticized as being incapable of explaining the emergence of complex form. (ACCNS) Salthe argues that additional factors—such as the Second Law—must be posited to account for developmental and directional trends in evolution. Given His critique of evolutionary theory, and his interest in renovating natural philosophy, we should not be surprised that he is something of a maverick in the scientific community, much of which remains attached to positivism, reductionism, and—Salthe opines--nihilism. Nevertheless, he describes his own position as a kind of materialism, influenced both by dialectical materialism and by Otto Neurath’s vision of the unity of the sciences. Salthe directs his cosmic myth at scientists, who—in his view—do not always appreciate the nihilistic implications of their typically unarticulated natural philosophies. He argues not only that human activity is entrained by an attractor leading us to destroy the conditions for our own survival, but also that science plays a major role in enabling those

destructive activities. Scientists who might otherwise balk at “New Age” recommendations, for example, engaging in contemplative practices to resist *consuming the planet*, might be more open to the suggested if it were presented in a rhetorically effective way, as in Salthe’s scientifically-grounded cosmic myth. Now, let us consider some of the chief features of this myth, features that resonate with key points of integral theory.

Hierarchies: Scalar and Specification

Drawing upon the work of Paul Weiss and Ludwig von Bertalanffy, Salthe argues that hierarchy theory offers an important way to interpret the interplay among levels in complex systems. (NPE, 1; SSHP; SP; EHS) There are two major kinds of hierarchies, scalar and specification. *Scalar* hierarchies, which represent a synchronic slice of a system, explain how a system maintains homeostasis in the face of perturbations from above and below. To examine a scalar hierarchy, an observer must select a focal level, which would lie in the middle, between a higher and a lower level. Because such levels differ from one another by about an order of magnitude, and because they have different temporal scales and dynamic intensities, events at one level tend not to affect other levels directly. Scalar hierarchy promotes system stability, because the upper scalar level dampens energy flows that might otherwise seriously disrupt or even destroy the level beneath. (NP, 9) Form is possible only in moderated energy flows. (NPW, 9) In the scalar triad, the lower level *proposes* (materially causes), while the upper level *disposes* (mediates what happens at the focal level). Possible development at the focal (middle) level, then, is limited by what the upper level will permit. (SONL, 336-337) As an example of a scalar hierarchy, Salthe offers the following: “[Earth [biome [population [organism [cell [macromolecule]]]]]], (where [is higher level [lower level]].” To use terms familiar to readers of *SES*, a cell is a holon that stands between the organism and macromolecules.^{vi}

A *specification* hierarchy may include the same levels present in a scalar hierarchy, but interprets the relation among them either historically, developmentally, or diachronically, rather than synchronically. A specification hierarchy “maps nature’s developmental trajectory”, with each new (higher) level marking “a new level of being.” (NPE, 3,1) There is no *tabula rasa* in the material world, however. Hence, “Wherever anything begins there are already some forms, propensities, and affordances, however vague.” (NPE, 12; ES, 135)) For instance, human consciousness is a late-stage specification of a propensity present in matter/energy from the very

beginning. As we will see later on, Salthe subscribes to pansemiosis and perhaps even to pan-experientialism and hylozoism. He writes that if meaning

can be successfully generalized from human language into the biology of cells, then nothing stands in the way of generalizing semiosis even further to abiotic dissipative structures, generating a pansemiotics. The motive for this position is ultimately to confront the problem of the origin of life. It is clear that, in a materialist position, nothing is derived from nothing; everything must have a predecessor. (NPE, 11)

In a specification hierarchy, levels emerge from one another in such a way that the emergent level (e.g., biology) harnesses or *integrates* the previous level (e.g., chemistry) for its own interests. (NPE, 3) Specification hierarchies are to be understood as highly complex, top-down, and organizational and integrative systems, which display “intensional complexity,” which means that to understand a complex system, one must examine it from several different perspectives. (NPE, 3) Following Aristotle, Salthe reads different integrative levels as “developmental stages in the ontogeny of the world.” (REPN, 1) By “development,” he means *progressive change*. (NPE, 3) Each level of a specification hierarchy is a *refinement* of the previous one, a refinement that harnesses and regulates the preceding levels. Higher levels *emerge* from and yet remain *dependent* on lower ones.

As an example of a specification hierarchy, Salthe proposes the following: {material world {organic world {biological world {social world {psychological world}}}}}, wherein {} represents a class. The inner terms within the brackets are included within a more encompassing class. As specification hierarchies develop, they move from vague to crisp (NP, 5), implying that they acquire ever-greater informational complexity, specificity, and constraints.

As a result, each more upper level opens up new degrees of freedom even as it further constricts lower level degrees of freedom. Upper level forms integrate lower level processes under their emergent rules, *but they do not transcend the lower ones; rather they supplement them*. In this sense the ontology represented is, loosely speaking, ‘materialist’. (NP, 10. Emphasis mine.)

In exploiting some possibilities while simultaneously closing off others, specification hierarchies ramify in a way akin to the branching of a tree. Because matter/energy was replete with possibilities right after the Big Bang, the possibilities actualized in our universe constitutes only *one* of a perhaps a very large number of *possible* developmental trajectories. In attempting to understand cosmic development retrospectively, we must recognize that things could have

developed differently. As Charles Peirce would have said, the universe could have acquired habits other than the ones it did. We are not in a position to make specific predictions about future development, although it will continue.

Development vs. Evolution

Salthe distinguishes between development and evolution. (DE) The former can be defined as “predictable directional change,” as in the developmental stages of an embryo. [REPH, 5] A general predictable developmental sequence, one to which Salthe frequently appeals, involves a three-stage process characteristic of all dynamic systems: immaturity, maturity, and senescence. We can also retrospectively discern a developmental trend in cosmic history after the Big Bang, even though no one (if anyone could have been there!) could have predicted where such development would head. Mainstream evolutionary theorists, including S.J. Gould, of whom Salthe is critical, indicate that evolution is a contingent and undirected sequence of historical changes. Whatever events have occurred in the history of terrestrial life in particular, according to Gould *et al.*, are the unplanned and unpredictable results of mutations that occasionally confer a competitive reproductive advantage to the affected organism. Salthe disagrees. Appealing to the idea of “general evolution” animating the work of natural philosophers such as Schelling, Spencer, and Peirce, Salthe conceives of evolution as an intelligible *developmental* process that ultimately

gave rise to humans as a result of working through some principles of change and/or reflecting some sort of finality. [In contrast] Darwinian evolution by natural selection is not a process as such, but mere will-nilly alterations taking place for no reason at all, driven and mediated by accidents and contingencies. That is to say, it is at base radically historical, and so, *unintelligible in the absence of other principles*. Insofar as natural selection has been demonstrated to occur [...] contemporary natural philosophy does not dismiss it, but relegates it to a subordinate role in evolution—the maintenance of adaptation to local conditions... as suggested by observations in nature. (NPE, 4. My emphasis.)

The Second Law as the final cause of cosmic development and form

What are these other principles that must be posited in order to account for cosmic, terrestrial, and human development? Salthe audaciously proposes that one such principle, perhaps the most important of all, is the Second Law of Thermodynamics, an enormously powerful cosmic attractor which everywhere urges reduction of order to disorder, so as to bring the far-from-equilibrium universe to a state of equilibrium, or entropy. Adapting Aristotle’s

doctrine of the four “causes” (material efficient, formal, and final), Salthe conceives of the Second Law as the *final* cause of cosmic development. Although modern science retained only two of Aristotle’s four causes, efficient and material cause (form being hidden as “formalism” in models and equations), Salthe maintains that the discovery of complex systems requires the reinstatement of final and formal causes. Unlike an efficient cause, which is a push from the past, a final cause may be understood as an attractor that *influences from the future*. (ES, footnote 7)

After the Big Bang, the clumping of matter/energy gave rise to gravitational attraction, the first indication that the universe was far from equilibrium. The Second Law emerges to correct this out of balance situation. Positing the Second Law as final cause assumes that the universe is an isolated system.^{vii} Closed and open systems are also subject to the Second Law, however. Accelerating expansion of the (known) universe has led it ever further from equilibrium, thus making the Second Law an ever more powerful and impatient attractor, capable of eliciting new forms that can assist in the demolition of other forms, in order to bring about Universal equilibrium, or maximum entropy globally. (BBP, 6) As open systems subject to the Second Law, life forms are not ends in themselves, but rather are clever means for degrading, simplifying, and disorganizing other forms, especially concentrated, far-from-equilibrium energy gradients. “Order, i.e., organization [...] could be viewed as being just a consequence of a system that is not able to reach equilibrium.” (Infodynamics, 6) Complex dynamic forms exist in a state of tension: they both seek to maintain themselves (and they do so by consuming—and thus degrading--other forms), but they are inevitably drawn toward self-dissolution as well. All complex systems, including organisms move toward senescence. The drive to continue is counterbalanced by the pull toward dissolution and recycling. In Salthe’s colorful formulation, the universe is governed by the principle of Shiva, the Hindu Goddess of creation and destruction: “[W]e are in a world that, in effect, does not want to be.” (BBP, 3)

Before going further, let us pause to review some pertinent issues about the Second Law. The Three Laws of Thermodynamics, and especially the Second Law, are often regarded as the most basic of all physical laws. Devised by 19th century scientist Rudolf Clausius, the Second Law is based on statistical analyses, according to which in an isolated physical system, a process can take place *only* if it increases the total entropy of the system. That is, organized energy available for work tends to become *entropy*, or disorganized energy unavailable for work.

Closed systems can exchange heat but not matter, with their surroundings; open systems (such as organisms) can exchange both heat and matter. Here is a classic example of the Second Law at work in a closed system. If someone opens the windows in warm house in the dead of winter, heat flows out into surrounding atmosphere, and the house rapidly grows cold. A major source of European nihilism and *ennui* fashionable at the end of the 19th century, the Second Law mandated that the universe was “running down” and would end in “heat death.”

Another 19th century thinker, however, Charles Darwin had theorized that life is not only evolving but also becoming more complex, even though Darwinian principles cannot adequately explain such directional development. Evolving life seems like a river running uphill. For decades, tension existed between physics, the universe is running down, and biology, the universe is winding up. There could be no unity of science, as Neurath opined, until these two trends could be reconciled. In *What Is Life?* (1944), physicist Erwin Schrödinger took on the challenge of explaining how life organizes, sustains, and reproduces itself, despite the Second Law’s pull toward entropy. He argued that organisms are open systems that live and reproduce by drawing upon and utilizing useful energy found in the environment. This process is inefficient, however, with typically less than 50% of available energy converted to useful work. Organism must pay a high entropy “tax,” in the form of dissipated energy, in order to survive. In the 1970s and 1980s, Ilya Prigogine developed the concept of “dissipative structures” to explain how all sorts of far-from-equilibrium, dynamic, open systems (ranging from tornadoes to life forms) arise and maintain themselves by drawing upon available energy.

Dissipative structures serve the Second Law

Salthe, along with theorists such as Eric D. Schneider, the late James J. Kay, Robert Ulanowicz, and more recently Dorion Sagan, posits that dissipative structures not only follow the Second Law, but also serve it.^{viii} The *final cause* of all dissipative structures is to use up concentrated energy—including energy that would not otherwise be tapped, such as underground oil exploited by humans--as rapidly as possible, so as to bring such energy into equilibrium, typically in the form of low-grade heat. Salthe writes that “energy dissipation is the key process in understanding all local events in our universe.” (REPN, 3) As noted earlier, dissipative structures *spontaneously* arise whenever their emergence can turn organized energy into entropy. Given that entropy production is a universal project, life-- far from being a highly improbable accident – “would be favored wherever possible.” (ID, 18; ES, 142)

According to Schneider and Kay, “if there is an energy gradient, then sooner or later a dissipative structure will form in apposition to it, or will discover and degrade it—and the bigger the gradient, the sooner this will happen.”^{ix} For example, the heat concentrated in the subtropical atmosphere *elicits* formation of heat-dissipating hurricanes. Salthe argues that “because form is capable of initiating orderly convective flows that move energy from gradients toward the [heat] sink more effectively than can haphazard conduction, like diffusion,” the evolution of life has been “a finalistic search for untapped energy gradients, seeking ever more finely tessellated and inaccessible ones.” (BBP, 5, 7) Various structures interrupt and delay the otherwise rapid degradation of high quality energy, such as sunshine, by imposing a cascade of hierarchically ordered systems, each of which produces work, between production of energy gradients and their final dissipation as heat. (ID, 2) The ultimate point of ecosystems and organisms, then, is to generate entropy.

Rapid consumption of energy gradients is inefficient and wasteful, yet greedy consumers (such as organisms) compete for the same resource, so it is *advantageous* to consume as rapidly as possible, rather than to get little or nothing at all. Organisms are relatively poor energy dissipaters, since much energy is used to maintain their own structures. By squandering a considerable portion of relatively high-grade energy in hasty consumption, consumers make its remnants available to other consumers further down the food chain, to such a point that life forms dissipate energy that might never have been dissipated. Salthe thus maintains: “[N]atural selection... tends to support systems that can most effectively produce entropy. In this way, *the Second Law constrains the results of natural selection....*” (BBP, 12. My emphasis.) Turning to ecosystems, Salthe remarks that their evolution, too, has multiplied avenues for entropy production. (NP, 6) Terrestrial evolution—organismal and ecosystemic—is not only inevitable, but also *meaningful*, in part because it is brought forth by the final cause of the universe, the Second Law.

Pansemiotics: Interpretation and experience go all the way down

Salthe uses the term “infodynamics” to refer to the fact that dynamic processes are meaningful, because they both generate and interpret information.

[T]he ‘meaning’ of high quality energy dissipation would be the development and support of some particular complex system. [...] Semiotically, the world does not merely ‘exist,’ but embodies meanings in its productions. Put another way, this thread of thought leads us to final causation. (ES, 134)

Complex dynamic systems do not merely *exhibit* meaning or purpose, they also engage in *interpretation*. Because they must take into account things necessary for their persistence, systems possess semiotic capacity. In explaining infodynamics and biosemiotics, Salthe refers to Von Uexküll's idea of an organism's *Umwelt*, the disclosive domain within which external resources pertinent to the organism manifest themselves as "indications" or "signs" that trigger off pertinent behaviors in the organism. Viewed externally, these signs would make up its niche. Salthe adds, however, that biologists must also take into account the interior, interpretative (semiotic) aspect of the organism, that is, its *experience*. (NPE, 15; MN, 5) Biosemiotics opens the way for global semiotics, according to which the highest known capacity for constructing and interpreting meaning (human intelligence) is an advanced specification of a vague capacity already present at the physical level. (MN, 2) Using Peirce's semiotic vocabulary, Salthe gives an example of such physical level interpretation: "[S]ensing the rate of local entropy production, the northern hemisphere air mass detects a too-slow turbulent dissipation, and in response constructs a slick tornado as its interpretant." (MN, 3) Viewing virtually all the complex systems in Nature as *agents*, Salthe contravenes mechanistically oriented scientists, for whom such an idea gets "in the way of dealing with [systems] instrumentally." (MN, 3) Salthe intends for that remark to sting scientists, who tend to think that a third-person, objectifying approach adequately explains the things under investigation. If everything other than humans (and perhaps we are no exception) is inert, unfeeling matter/energy, there is no limit to what we can do to things. What "we" are doing, however, is making the biosphere unfit for human habitation. Therefore, we might add, the objective, mechanistic approach was in a broader than instrumental sense, *wrong*.

Cosmic nihilism?

Salthe's cosmic myth is a nihilistic narrative, according to which developmental history has been entrained by the Second Law. In this narrative, the Second Law tolerates life, but compels it to serve the final end of producing entropy. Life itself becomes meaningless, once one understands what is really going on. Salthe has indicated, however, that his myth is meant in part to be ironic. "My hope," he writes, "is to present (as the mythic implication of science texts) such a horrid picture that folks will ask: 'Is that *really* the implication?'"^x Through his cosmic myth, then, Salthe wishes to provoke scientists to take a look at what may be behind their worldview, which is typically aligned with the project to control nature. Influenced by Romanticism, Salthe hopes to evoke a heroic response, a great refusal to further cooperation with

the Second Law as embodied in capitalism (whose motto is “Grow or die!”), and a struggle against our own natural tendencies.

First-person experience and cultural interpretations of the Second Law

Salthe’s Second Law myth may provide an explanation for the fact that individual human experience is replete with desiring, willing, aggression, yearning, violence, and suffering. German philosopher Martin Heidegger holds that Will is modernity’s major metaphysical category, articulated in Nietzsche’s idea of the Will to Power and embodied in industrial technology.^{xi} Earlier, the German idealist, F.W.J. Schelling asserted that “there is no other being but willing. Willing is primal being....”^{xii} In humans, according to Schelling, this willing takes the form of the incessant yearning for freedom. Schelling’s work influenced Arthur Schopenhauer, according to whom all phenomena are manifestations of a blind, striving, relentless cosmic Will that can never attain the satisfaction that it craves. Experienced by humans, Will reveals itself as sexual desire, aggression, and the hankering for survival, all of which inevitably lead to suffering, which Schopenhauer maintained could be alleviated by recommended by Buddhism and other spiritual traditions. Sigmund Freud spoke of the ineradicable and competing pull toward work, creation, and eros, on the one hand, and violence, destruction, and death, on the other. In *Civilization and its Discontents*, he maintains that people are pulled toward self-destructive activities, so that they can return to a state lacking in tension, that is, death, in which the body turns into inert chemicals. Buddhism maintains that human suffering arises because we are in the grip of the *three poisons*: craving (greed), aversion (hatred), and ignorance (delusion). Addicted to these poisons, we wander aimlessly through *samsara*. In contrast, *nirvana* promises to silence the roaring within, and thus to extinguish the flames of desire, hatred, and delusions.

From the Second Law perspective, we may read craving as the interior manifestation of the universal imperative to consume energy gradients as rapidly as possible; violence as a manifestation of the yearning to destroy all forms; and ignorance as not only blindness in the face of impermanence, but also delusional strategies (God projects) designed to overcome death. Sexual desire (*eros*) leads to copulation and reproduction, while death drive (*thanatos*) elicits murder and warfare. For many centuries, commentators from many different traditions have remarked upon the cloud hanging the heads of human beings, who seem impelled to destroy the things (and people) they love. People are restless, impatient, dissatisfied, ambitious, and often

obsessed with security and vainglory (or any number of other things). Of course, such behaviors are also wellsprings for creativity and inventiveness. Without dissatisfaction, people would lack the incentive to create alternatives to the given, yet such dissatisfaction simultaneously leads us to covetousness, jealousy, and hostility.

Like individuals, cultures must find ways to survive “in a world committed to the destruction of all forms.” (BBP, 11) According to Salthe, cultures survive not only by adhering to supportive traditions, but also “by paying entropy tribute, as by building pyramids and airplanes, and, of course, by then destroying them in wars.” (BBP, 11) That is, cultures build all sorts of things in line with the imperative to consume organized energy. This imperative also helps to explain why humans so often engage in warfare. Seen from the lowest integrative level (physical), warfare lets entropy “be extracted from cultural artifacts as they get recycled, making way as well for more entropy-taxed construction.” (BBP, 12) To be sure, other factors are also at work in deciding whether or not to go to war. Salthe remarks that in complex social situations we should regard the Second Law

as a continually attracting *weak force* that never lets up, such that if higher level tendencies tend to cancel each other out, it is right there influencing decisions. So, "Shall we go to war?" On the one hand, “yes,” on the other, no." In this stalemate the vote leans toward “yes.”

Of course, global nuclear war would produce a gargantuan amount of entropy, but immediate annihilation of humankind and so many of its products would prevent future humans from cleverly drawing upon vast energy gradients, including coal, gas, oil, and uranium, to name the ones known to us today. Given how effective humans are at generating entropy—putting the pedal to the metal big time--, one could even argue that the Second Law has an interest in preserving our species for as long as possible!

According to Salthe, the universal developmental sequence of immaturity, maturity, and senescence may also help to explain the historical prevalence of warfare. An immature systems greedily consumes as much and as fast as possible; consumption slows down at the mature stage, when systems becomes increasingly burdened with information and set in their ways; in senescence, information overload rigidifies a system and brings it to the point of collapse, at which time its components are recycled. Faced with war, a society must either re-energize itself, or perish. Hence, warfare may be “interpreted as a mechanism to prevent ecosocial senescence.”

(ID, 1) Perhaps the drive to avoid senescence helps to explain why old men send young men to war.

Salthe also suggests that global capitalism has in effect been “selected” by the Second Law, because capitalism so effectively enables people to use up vast stores of energy and material. Today’s environmental problems do not constitute a deviation from some more “natural” way of life, in which people lived harmoniously with nature. Even if some cultures once followed this path, the “winners” have been cultures in which individuals have worked as hard as possible to survive and prosper. Salthe remarks: “our efforts to sustain ourselves as embodied beings constitute our worship of and service to, the more general and eternal thermodynamic Law, which accepts our sacrifice as it consumes us. If there is a moral implication lurking here, it might just be the work ethic.” (CB, 300) The work ethic has spread everywhere, such that the entire surface of the planet is seething with energy harnessed for production, consumption, and destruction.

Final causes other than the Second Law

Critics charge that Salthe’s natural philosophy is reductionistic, insofar as it interprets all activity (interior and exterior, cultural and social) in terms of the Second Law, which was originally developed to explain energy-transfer at the physical (molecular) level. Salthe concedes that complex systems exist not only because of the Second Law, but “for various other reasons as well, all of these reasons [...] being consistent with the primary finalism [entropy production].” (BBP, 5) A more generally applicable explanation of a phenomenon is preferable because it facilitates comparative studies of interest to a unified view of nature and thus to the unity of the sciences. Moreover, the thermodynamic basis for Salthe’s cosmic myth “appears most clearly at the most general (physical) level.” (BBP, 1; CB, 297) Instead of being a full (all-level) program of understanding, then, Salthe’s project seeks to understand

complex systems from a quite low integrative level, i.e., the material, from the intensional complexity [specification hierarchy] perspective. [...] Infodynamics need not be in conflict with more specified theories deployed at other levels of integration, provided that they do not abrogate or transcend the constraints imposed at the lower levels. [...] Infodynamics is *necessary but insufficient* for understanding ecosystems [or human societies, MZ].” (ID, 19. My emphasis.)

In other words, the Second Law remains in play at the highest integrative levels, even though other “final causes” are also at play. Higher levels cannot *transcend* lower ones, but

instead are logically *refinements, specifications, or intensifications* of them. “Evolution probes deeper and deeper into the possibilities chosen, but as it does so, it leaves behind more and more possibilities.”^{xiii} Hence, one may expect to see the final cause (Second Law) operating at *all* levels, even though it is most immediately applicable at the physical level. For instance, in the human world, the existence of a steep gradient—such as prestige or power—*invites* social revolution to dissipate that gradient, after which revolutionaries would build up a new social gradient. Insofar as social revolution is “a more highly specified example of the same principle [Second Law], and not a mere analogy,” we can see how focusing “on the most general level has the unifying effect proper to a naturalized myth.” (CB, 298) Of course, if human development is a final cause for social organization, we could argue that revolutions—whether violent or not—have sometimes been inspired by and have also helped to institutionalize universal moral principles, which include all humans (and increasingly sentient non-humans) in the domain of moral considerability.

Salthe mentions several final causes apart from the Second Law. These include the following:

1) *Discourse* can act as a final cause in making observations and drawing conclusions. (For example, the final cause of the importance of natural selection in our current representation of Nature is that this ‘Nature was constructed by thinkers in a capitalist economic system.’) (NPE, 8)

2) Final cause is at work in *complex, multiply scaled systems*, when perturbations from higher scale boundary conditions “call for” something from below, by imposing regulatory boundary conditions.

3) A final cause important for ecological systems is the pull of *deep structural attractors*, a notion developed by Peirce as cosmic “habits.”

4) Salthe also maintains that: “Any continuing system needs to rely upon the ability of its components to be assured of the continuing validity of their *future progressive expectations*. These act as final causes....” (ES, 134) Put otherwise, “the innermost or highest integrative level of any system has the role of Telos, final cause.” (NPE, 8) Even more emphatically, Salthe writes:

In a specification hierarchy the observer / discourse (as the innermost subclass) can, in some readings, be taken to be *the final cause of the development of the world*—that is, as the beginning of a series of implications...as in: discourse

implies (or conceptually subordinates) biology, biology implies chemistry, chemistry implies a physical world. This is a logically based version of the physicist's anthropic principle. (NPE, 4. Emphasis mine.)

Primordial Mind

There are several versions of the anthropic principle, but the most pertinent and controversial one is this.^{xiv} The existence of conscious life forms implies that cosmic history was entrained *from the future* by the requirements needed for the emergence of such life forms, which acted from the future as final causes or attractors, luring the universe to evolve in a certain direction. Salthe notes approvingly that earlier natural philosophers interpreted evolution as a developmental (thus intelligible) process that “gave rise to humans as a result of working through some principles of change and/or *reflecting some form of finality*.” (NPE, 4; italics mine) Is it possible, then, that there is some cosmic finality at least as powerful as the Second Law?

In his essay, “The Cosmic Bellows,” Salthe makes another intriguing move. He notes that his inquiry is concerned not with “the ultimate underpinnings of physical reality but only with the material world, i.e., the world of things which beings of our scale deal with more or less directly.” (CB, 300) Then, he introduces the following specification hierarchy: “{Primordial Mind {inorganic realm {organic realm {biological realm {cognitive realm}}}}}}.” Salthe reports that he considered using “Logos” instead of primordial Mind, a term (and to some extent a concept) borrowed from Peirce. (CCC, 5) By maintaining that cognition is a final cause for cosmic evolution, and then by adding that cognition itself is a class within the set called primordial Mind, Salthe puts a new spin on his Second Law myth. We may ask: to what extent does this new version resonate with Wilber’s notion of divine Eros as the cosmic attractor that stands in the future, influencing prior universal self-organization and development?

Primordial Mind is the outermost and thus most general integrative member of a specification hierarchy, of which human cognition (mentality, mind) is the innermost class. This apparent paradox (mind is included within Mind) may be solved by saying that “thought is a process internal to any classifications that it may construct, including concepts of the mind Formally, thought processes would be an integrative level contained within the class Mind, or more simply, one aspect of mentality—the system is self-referential.” (CCC, 4) In other words, primordial Mind develops in a way that eventually allows for particular cognitive acts, including the one that constructs the specification hierarchy under consideration. Additionally, cognition

itself may be understood as a final cause that has entrained at least one branching evolutionary pathway so as to make possible the development of mind.

The Second Law does not obtain in primordial Mind, because that Law arose only *after* the Big Bang, which (along with the rest of material nature) is an event that occurs and develops *within* primordial Mind, the most general class of the specification hierarchy in question. “In primordial Mind there was (and/or is) no dissipation. This would imply that the material world had its own origin because, in my view, the essential nature of the material world is friction, delay and dissipation.” (CCC, 4) Cognition is an intensification and enhancement of an extremely vague possibility within primordial Mind, which “refers to pure potentiality—the source of everything else. Peirce took it to be a primal firstness—all possibility.” (CCC, 5) Certain sorts of materialists might be unhappy, but the self-described materialist Salthe assuages them as follows: “[A]ll I am saying here again is that the material world itself had a particular origin, and that *what was before that was not material*—just as organic evolution had an origin [...] and that systems prior to its inception did not evolve.” (CCC, My emphasis.)

Cosmic Mind and Non-dual Spirit

We do not know how or why the Big Bang was initiated, but soon thereafter the Second Law arose to begin its relentless sculpting and refining work, drawing out ever more complex forms needed for entropy production. Yet, if the Second Law entrained the emergence of cognition (self-conscious life) as a specification of primordial Mind, cognition itself exerted *from the future* another entrainment on--another final cause for-- that same developmental trajectory. This is another way of articulating the notion discussed earlier, namely, that the cosmos is pulled not only to self-dissolution, but also to self-enhancement, perhaps especially in the form of self-consciousness. Could the Second Law, then, be viewed as a final cause subordinate to one of the classes (cognition) that it helped to make possible? If so, could we read Salthe’s cosmic myth as to a considerable extent consistent with cosmic narratives (such as those formulated by Sri Aurobindo, Swimme and Berry, Wilber, and others) that cosmic history is the story of Spirit not only evolving to become aware of itself within the limits of the material world, but having always already exerted influence on that world sufficient to make such self-recollection possible?

According to Ken Wilber, nondual Spirit, not the Second Law, is the major strange attractor for cosmic development. Defining nondual Spirit seems impossible, however, given that human cognition is designed to describe the world of form, not the “causal unmanifest.” (SES,

323) Nevertheless, Wilber indicates that Spirit is the Omega point that not only lures matter-energy into producing form after the Big Bang, but somehow occasioned the Big Bang itself. Of course, since time arose *with* the universe, one is hard pressed to speak of Spirit as being either before or after the Big Bang, or even as “being” at all. Despite the daunting metaphysical issues involved here, Wilber writes: “Thus, in the world of form, the *ultimate Omega* appears as an ever-receding horizon of fulfillment, forever pulling us forward, forever retreating itself.” (SES, 324. My emphasis.)

When presented with Wilber’s claim that Spirit is the ultimate lure for form, Salthe indicated that his specification hierarchy of primordial Mind “amounts to the same proposition.”^{xv} But, does it? Salthe and Wilber understand the term “ultimate” differently in this context. According to Salthe, ultimate would mean—at least from the Second Law perspective—the ineradicable pull of the Second Law, which is the most important factor in the second class (physical) within the set enclosed within the primordial Mind hierarchy. The Second Law, however, arose in reaction to the disequilibrium that occurred *within* space/time *after* the Big Bang. In contrast, Wilber says that Spirit is ultimate both because it transcends space/time, matter/energy, and form, even though Spirit provides support and telos for every moment of evolution. (SES, 323) Yet what Salthe calls primordial Mind also seems incapable of being understood in terms of space/time, matter/energy, and form, although Mind must have foreshadowed them. By speaking of Mind as “pure potentiality,” Salthe would seem to move close to the notion of Spirit as pure possibility, as the context of all contexts, with no beginning and no end, forever differentiating itself and beginning anew.

Recently, however, in reply to my inquiry about this issue, Salthe wrote that—at least in this context—he prefers to invoke not “pure potentiality,” but instead “vagueness” as the descriptor for Universal Mind.^{xvi} Development always moves in this way: {vague {less vague {more definite}}}. Mind as vagueness, then, is in some sense “actual,” though how its pre-physical actuality relates to post-physical actuality is difficult to define. Many contemporary scientists, however, agree with Salthe that understanding complex dynamic systems requires a logic of vagueness (fuzzy logic is a start, at least), which would counteract science’s linear and explicit modeling that conceals as much as it reveals. For Salthe, development involves the ever-greater specification of the vague or merely implicit. Hence, the specification hierarchy model may be understood “as a tree expanding from vagueness into many branches.”^{xvii} Primordial

Mind as indeterminate, vague, but enormously fecund source could allow countless universes, to emerge, including our own.

Because Wilber defines development somewhat differently, his nondual Spirit as “ultimate” attractor differs from Salthe’s primordial Mind. Wilber writes:

Every senior dimension [of a holon] acts as a transformative omega point for its junior dimension, exerting a palpable pull of the *deeper and wider on the shallower and narrower*. [...] Each deeper and wider context in the Kosmos thus exerts an omega pull on the shallower and narrower contexts, and when that particular wider depth is reached, that particular omega pull subsides, with the new depth finding that it now exists in a yet-wider and yet-deeper context of its own, which now exerts an unrelenting omega force to once again transcend, to once again embrace more of the Kosmos with care and consciousness. (SES, 319-320)

For Salthe, development involves a deepening but *narrowing*, i.e., specification. For Wilber, in contrast, development involves a deepening and *widening*, that is, development achieves greater inclusion, comprehensiveness, and integration. Hence, for example, instead of interpreting the biological domain as a specification of the physical, Wilber holds that the biological brings forth a *new*, emergent capacity. Such a capacity must be consistent with structures of the physical domain, which is more fundamental than the biological, but the biological is more than a *refinement* or specification of the physical. What “emergence” and “novelty” mean in regard to development is, of course, a vexed issue. Despite points of agreement, then, Salthe and Wilber differ in important ways about the relation between earlier and later levels of development.

For Wilber, the ultimate Omega refers to the pull exerted by nondual Spirit, the infinite context of all contexts, which urges all beings to attain their greatest depth, at which point another yearning arises for yet greater depth (and inclusivity) arises, leading to another stage in evolutionary development. Resisting Salthe’s notion that the point of the universe is to dissolve itself, Wilber suggests instead that we can interpret the universe as seeking to bring forth beings capable of ever greater compassion and wisdom. Even if the universe finally winds down or becomes dispersed because of rapid acceleration, attainment of such depth, breadth, and inclusiveness may have been worth the effort. But, such an effort! Wilber does not offer naïve cosmic consolation for the myriad beings subject to birth, suffering, and death over the eons.

Indeed, the consequences of Spirit's constant pull resemble in some ways the nihilism in Salthe's cosmic myth.

Evolution seeks only this Formless *summum bonum*--it wants *only* this ultimate Omega--it rushes forward always and solely in search of *this*--and it will *never* find it, because evolution unfolds in the world of form. [...] And since [evolution] will *never* find [the timeless], it will *never cease* the search. *Samsara* circles endlessly, and that is always the brutal nightmare hidden in its heart. (SES)

Salthe agrees that *samsara* is an apt term for describing a pitiless world striving to create form while simultaneously yearning to destroy it.^{xviii} Likewise, Wilber argued in a number of his earlier works that people have long engaged in ambitious though futile "God projects," large and small, designed to make either themselves or their cultures immortal, but typically wreaking destruction at the same time.^{xix} Arguably, humans rage against finitude and struggle to become godlike, because they have had a taste of eternal Spirit. Beings find themselves in a highly unsatisfactory condition: somehow arising by virtue of nondual Spirit, they long to become that Spirit, but temporal beings can never hoist themselves up so high. Ever new forms are drawn up in hope that the *next* one will do the job, but each new form--however remarkable its emergent properties--remains separate from uncreated and formless Spirit. The ceaseless yearning, striving, desiring, clamoring, resisting, hating, fighting--all may be read paradoxically as a deep yearning *not to be*, at least not to be in the realm of form. Wilber's notion that life in the realm of form is a "brutal nightmare" resonates with the view at work in Salthe's cosmic myth of the Second Law.

In Salthe's cosmic myth, the *yearning not to be* is constantly in tension with the *necessity to be*: "We need to 'be' in order to mediate nothingness," that is, to bring about dissolution of some forms by creating countless new ones.^{xx} In an expanding universe, global entropy is unattainable, however, a conclusion that makes all the sound and fury involved in cosmic development even more dispiriting.

According to Wilber, we *have to be* because nondual Spirit has lured us into existence. Once alive, however, we yearn to survive, yet we *do not want be* conditioned beings wandering in *samsara*. Our desire to become formless Spirit even while having arisen as matter and form, however, cannot be satisfied. "The Formless ...is indeed an ultimate Omega, an ultimate End, but an end that is never reached *in* the world of form. Forms continue endlessly, ceaselessly,

holarchically forever....” (SES, 324) Even if *this* universe collapses back into itself in the Big Crunch, forms continue endlessly all the way up and down, “in billions and billions of other universes!”^{xxi} (SES, 324)

“Why” either primordial Mind or nondual Spirit allows countless universes, in all their triumph and tragedy, to arise in the first place will perhaps always remain a mystery. Some traditions speak of the world as a cosmic “play” or “sport,” lacking in “reasons” that would satisfy our search for justification. All contemplative traditions agree that because humans are enslaved to craving, willing, desiring, aggression, and pride, they should avail themselves of practices aimed at ending such enslavement. Advanced contemplative practitioners typically report transpersonal experiences in which ego, objects, existence, space, and time eventually vanish altogether. From the transformation brought about by exploring absolute Nothingness, one discovers that form and formless, world and Spirit are in mutual embrace. Based on such experience, Wilber recommends following the path described by Mahayana Buddhism: “Abide as Emptiness, embrace all Form: the liberation is in the Emptiness, never finally in the Form (though never apart from it).” (SES, 324) Salthe indicates that his own modeling of primordial Mind as creative vagueness stems in part from nondual experiences of his own.^{xxii}

What’s the Difference?

Given that both Salthe and Wilber agree that cosmic development involves a constant struggle between the intertwined polarities of creation and destruction, wanting to be and wanting not to be, what *difference* does it make if one person says that the “attractor” generating this struggle is the Second Law, and another person says that the attractor is instead nondual Spirit? Both are “big picture” ways of making sense of things, not assertions capable of being judged as either true or false. Either position can elicit the same response: resignation on the part of people who conclude that individual effort is pointless in the face of such powerful cosmic forces. As Salthe points out, however, this is our scientific culture’s tacit answer to the question of the “meaning of life,” even though individual scientists would try to evade such this judgment.^{xxiii} Both positions are frank about the inescapable limitations imposed upon beings in the realm of matter and form. Both narratives are powerful, persuasive, and thought provoking.

Wilber’s narrative does offer certain advantages, in my view. First, it provides a far more elaborate, multi-perspectival account of physical, biological, and mental development than does Salthe’s myth, the scope the latter being limited because of its scientific audience, although

the goals of Salthe's myth are no less ambitious than Wilber's. Wilber's more inclusive narrative can more effectively explain the *limits* of the Second Law's influence on higher developmental levels than can Salthe's. Further, Wilber acknowledges the various destructive aspects of modernity, including capitalism, but simultaneously emphasizes modernity's noble and constructive aspects, such as personal freedom, freedom of inquiry in science, religion, and art, institutionalizing of (relative) liberty in social and political structures, great increases in life span, enormous gains in material wealth, and extraordinary developments in science and technology. By underscoring that modernity has alleviated much suffering while simultaneously opening up many new avenues for satisfaction, Wilber justifies on-going efforts to promote individual and cultural development, *even within the samsaric world*.

In contrast, Salthe's narrative—despite the influence of aspects of dialectical materialism--sometimes exhibits a romantic anti-modernism, which tends to discount the positive developments of modernity. Like Salthe, Wilber is well aware of the dark side of modernity, and also emphasizes the new sorts of pathology accompanying every newly acquired stage of human development. In the case of modernity, such pathology includes an “othering” of nature that threatens the viability of our own species.

Further human developments may be entrained by an as-yet-specified possibility already influencing the present. This possibility might include what Ray Kurzweil and others refer to as “post-humans” endowed with intelligence, subjectivity, and power unimaginable to us.^{xxiv} Drawing on the work of Vladimir Vernadsky and Teilhard de Chardin, Salthe foresees the rise of the noosphere, the developmental stage in which humankind gains total technological domination of the planet. This, of course, would presumably wreak havoc on ecosystems. According to Salthe, however, even a remarkable hyper-system like the noosphere would end in senescence, as will the Earth's biosphere itself. Kurzweil and his colleagues would reply that the aim of post-humans is to become non-biological beings capable of abandoning planet Earth. Presumably, Salthe and Wilber would agree that even such extraordinarily advanced post-humans—who strive for immortality and even a measure of divinity--could not succeed in transcending the limits imposed by matter and form.

The role of contemplative practice

The narratives composed by Salthe and Wilber are informed in part by their own spiritual explorations, which allow both of them to recommend contemplative practices as a way of

limiting entrainments that produce endless craving for what cannot be. Toward the end of “The Cosmic Bellows,” Salthe mentions practices that might be useful in disclosing and resisting our cravings, our destructive urges, and our fantasies about achieving immortality. His cosmic myth has already *oriented* us: We are entrained by a powerful attractor that has no interest in our lives, our communities, our values, our histories, except insofar as these somehow contribute to entropy production. Now, he offers some *hope*. At first, speaking mostly with tongue in cheek, he states that resisting capitalism’s prime virtue, consumption, would entail honoring practices now depicted as vices: “laziness, procrastination, overcautiousness, and indecision, the last two of which are cousins to complexity....” (CB, 311) Going up against a law of nature, however, would require exceptional discipline, rather than laziness. Now, he braves the suggestion that *contemplative practices* would allow us to observe and to accept our passions, without giving in to them. (CB, 311) Such practices would be a crucial element in humanity’s struggle to free itself from the excesses called forth by the Second Law, which shows up as insatiable desire and frequent aggression. As more people attain higher levels of consciousness, and are thus more capable of renouncing the pulls to war and destructive consumption, mature countries may find ways to sustain themselves longer, before succumbing to inevitable senescence. Calling to mind a passage cited by Swimme and Berry, in which a wise man notes that loss and sorrow always accompany even genuine advances, Salthe appeals to those traditions that teach *equanimity* when confronting the irresolvable tension and inescapable suffering that courses through human life. (CB, 312-313)

For the awakened, the end of *samsara* brings the dawn of infinite compassion for all who remain attached to matter and form. In non-dual Spirit, nothing needs to be attained, because everything is always already complete. Hence, whatever takes place in the realm of matter and form—regression, progression, or stasis-- cannot disturb either primordial Mind or nondual Spirit.^{xxv} Dwelling within such a transformational realization, one can work tirelessly to promote well-being for all, even while recognizing that one’s efforts will in most cases be futile.

Abbreviation key to references to Salthe’s essays.

Page references are to essays as they were printed out either from Salthe’s home page, <http://www.nbi.dk/~natphil/salthe/>, or from his collection of on-line essays: <http://www.harmony.com/twiki/bin/view/Main/SaltheResearchOnline>

- ACCNS, "Analysis and Critique of the Concept of Natural Selection" (2006). URL: http://www.nbi.dk/~natphil/salthe/Critique_of_Natural_Select_.pdf
- BBP, "Becoming, Being and Passing: Our Myth from Science (the Second Law and Natural Selection)," URL: <http://www.nbi.dk/~natphil/salthe/>, 2002.
- CCC, "A Classification of Closure Concepts," *Annals of the New York Academy of Sciences* 901 (2000), special issue of *Closure: Emergent Organizations and their Dynamics*, ed. Jerry L. R. Chandler and Retrudis Van de Vijver, 35-41. URL: <http://www.annalsnyas.org/cgi/content/full/901/1/35?ck=nck>
- CB, (co-authored with Gary Fuhrman,) "The Cosmic Bellows: The Big Bang and the Second Law." *Cosmos and History: The Journal of Natural and Social Philosophy*, Vol. 1, No. 2 (2005), 295-317. URL: <http://cosmosandhistory.org/index.php/journal/article/view/44/25>
- DE: *Development and Evolution: Complexity and Change in Biology* (Cambridge: MIT Press, 1993).
- EHS, *Evolving Hierarchical Systems* (New York: Columbia University Press, 1985).
- ES, "Energy and Semiotics: The Second Law and the Origin of Life," *Cosmos and History: The Journal of Natural and Social Philosophy*, Vol. 1, no. 1 (2005), 128-145. URL: <http://www.cosmosandhistory.org/index.php/journal/article/viewFile/26/8>
- ID, "Infodynamics: A Developmental Framework for Ecology/Economics." *Conservation Ecology* 7 (3), article 3. URL: <http://www.consecol.org/vol7/iss3/art3/>
- MN, "Meaning in Nature: Placing Biosemiotics within Pansemiotics," in *Biosemiotics: Information, Codes and Signs in Living Systems*, ed . Marcello Barbieri (New York: Nova Science Publishers, 2007), 207-217.
- NP, "Natural Philosophy: Developmental Systems in the Thermodynamic Perspective," URL: http://www.harmony.com/twiki/pub/Main/NaturalPhilosophyPaper2006/Natural_Philosophy06.pdf
- NPE, The Natural Philosophy of Ecology: A Developmental Systems Approach," *Ecological Complexity* 2 (2005), 1-19. URL: <http://www.nbi.dk/~natphil/salthe/>
- NPW, "The Natural Philosophy of Work," *Entropy* (2007), 83-99. URL: <http://www.mdpi.org/entropy/papers/e9020083.pdf>
- REPN, "The Role of Entropy in the Philosophy of Nature." URL: <http://www.harmony.com/twiki/bin/view/Main/SaltheResearchOnline>
- SP, "Summary of the Principles of Hierarchy Theory" (2001), URL: http://www.nbi.dk/~natphil/salthe/Summary_of_the_Principles_o.pdf
- SSHP, Stanley N. Salthe Home Page: <http://www.nbi.dk/~natphil/salthe/>
- SONL, "The Spontaneous Origin of New Levels in Scalar Hierarchy," *Entropy* (204), 327-343. URL: <https://www.mdpi.org/entropy/papers/e6030327.pdf>
- At this link, one can find references to Salthe's publications by topic: http://www.nbi.dk/~natphil/salthe/publ_classified_by_topic.pdf
- At this link, one can find many of Salthe's publications on line: <http://www.harmony.com/twiki/bin/view/Main/SaltheResearchOnline>

ⁱ Ken Wilber, *Sex, Ecology, Spirituality* 2nd edition (Boston: Shambhala, 2000), p. 85. Henceforth, SES.

ⁱⁱ SONL. 341. Emphasis mine.

ⁱⁱⁱ CB, 299. See also Salthe, BBP, 3.

^{iv} Among the best are Brian Swimme and Thomas Berry, *The Universe Story: From the Primordial Flaring Forth to the Ecozoic Era--A Celebration of the Unfolding of the Cosmos* (New York: HarperOne, 1994), and Wilber, *Sex, Ecology, Spirituality*.

^v Personal communication.

^{vi} By placing Earth at the top of the *scalar* hierarchy, Salthe is not suggesting that there was no Earth prior to the emergence of the preceding scalar levels. The scalar hierarchy is synchronic and spatial, not diachronic, that it, conceives of scalar hierarchies as nested one within the other, without

providing a developmental, historical, diachronic account of how such hierarchies arose or relate to one another in terms of complexity. These issues are addressed in the specification hierarchy.

^{vii} See “Thermodynamic System,” *Wikipedia*, in which in which isolated, closed, and open systems are usefully defined. URL: http://en.wikipedia.org/wiki/Thermodynamic_system Accessed June 25, 2008.

^{viii} See Eric D. Schneider and James J. Kay, 1994, "Life as a Manifestation of the Second Law of Thermodynamics", *Mathematical and Computer Modeling*, Vol. 19, No. 6-8 (1994), 25-48; Eric D. Schneider and James J. Kay, "Order from Disorder: The Thermodynamics of Complexity in Biology", in Michael P. Murphy, Luke A.J. O'Neill (ed), "*What is Life: The Next Fifty Years. Reflections on the Future of Biology*" (New York: Cambridge University Press, 1995), 161-172; Eric D. Schneider and Dorion Sagan, *Into the Cool: Energy Flow, Thermodynamics, and Life* (Chicago: University of Chicago Press, 2006); and Robert E. Ulanowicz, *Growth and Development: Ecosystem Phenomenology* (New York: Springer-Verlag, 1986).

^{ix} Cited by Salthe, NP, 7; see also Salthe, SONL, 331.

^x Personal communication.

^{xi} For an overview of this topic, see Michael E. Zimmerman, *Heidegger's Confrontation with Modernity* (Bloomington: Indiana University Press, 1990).

^{xii} F.W.J. Schelling, *On the Essence of Human Freedom* (1809), as quoted by Andrew Bowie in “Friedrich Wilhelm Joseph von Schelling,” *The Stanford Encyclopedia of Philosophy*. URL: <http://plato.stanford.edu/entries/schelling/> Accessed June 28, 2008.

^{xiii} Salthe, personal communication.

^{xiv} For a brief overview of the anthropic principle, see Steve Paulson's interview with Paul Davies in *Salon*. URL: http://www.salon.com/books/feature/2007/07/03/paul_davies/ An excellent physicist, Davies has published many semi-popular books about the nature of reality, which he regards as saturated with meaning and purpose.

^{xv} Personal communication.

^{xvi} Personal communication.

^{xvii} Personal communication.

^{xviii} Personal communication.

^{xix} See Ken Wilber, *Up from Eden: A Transpersonal View of Human Evolution* (Wheaton, Illinois: Quest Books, 1996 [1981], and *The Atman Project* (Wheaton: Quest Books, 1980).

^{xx} Personal communication.

^{xxi} Salthe comments that the current condition depends on the acceleration of the universe remaining more or less the same. If it were to decelerate, then, on my view, the magnitude of gravitation and its dual, the Second Law, would diminish, and the result is a situation so uncanny I cannot imagine it. Personal communication.

^{xxii} Personal communication.

^{xxiii} Personal communication.

^{xxiv} See Ray Kurzweil, *The Singularity is Near: When Humans Transcend Biology* (New York: Penguin Books, 2006); Michael E. Zimmerman, “The Singularity: A Crucial Phase in Divine Self-Actualization?” forthcoming in *Cosmos and History*.

^{xxv} I would like to express my deep appreciation to Stanley N. Salthe for being such a generous and insightful interlocutor about the many topics that he and I have discussed. He also offered several suggestions for improving the present essay, though of course any remaining problems are my responsibility.