THE ONTOPOLITICS OF COMPLEXITY:

TOWARD AGONISTIC DEMOCRACY AND ECOLOGICAL POLITICAL ECONOMY

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Abstract:

Complexity is among the most used yet rarely defined and often misunderstood terms in sustainability science. In this text, I argue that the conventionalization of the concept of complexity has resulted in the conflation of "thin" (i.e., reductionist) complexity and "thick" (i.e., perspectivist) complexity, and the resultant confusion surrounding these categories has created unnecessary tensions between sustainability science and environmental justice. Employing William E. Connolly's ontopolitical-genealogical approach, I tease out implicit ontological commitments relating to complexity, holism, organicism, and environmental determinism, in the intellectual history of systems theory, cybernetics, and theoretical ecology. I critique key interlocutors in the pluralism debate within ecological economics to illustrate how conventionalized complexity has created barriers to pluralistic engagement between ecological economics and political ecology. Following radical democratic theorists, I argue that the distinction between thick and thin complexity is essential to fostering "agonistic pluralism" between sustainability science and environmental justice while also serving as a defence against the misuse of systems concepts by anti-pluralists, authoritarians, and technocrats. I argue that totalizing, functionalist expressions of systems theory exacerbate political violence by displacing political discourse and serving as a pretext for ecofascism. As an alternative to functionalist organicism, I articulate a relational ontology of life, in the tradition of Robert Rosen and Terrance Deacon, that creates affordances for agency that is both creative and reflexive. I explore how such an ontology destabilizes politically conservative, neoliberal, anti-pluralist interpretations of thin complexity, and I argue that thick complexity, relational holism, and teleodynamism can serve as core concepts for a more robust discourse in ecological political economy that is concurrently attentive to the dual imperatives of biophysical limits and environmental justice.

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Prologue: Humanism at the End of History

> It is relatively easy to promote good and to fight evil when evil and good are arranged against one another in two clear lines. and when those on the other side are our unquestioned enemies, those on our side our trusted allies. What, however, if we must ask, each time in every situation, where is the friend and where the enemy? What, moreover, when we have put the decision in the hands of an inexorable magic or an inexorable machine of which we must ask the right questions in advance, without fully understanding the operations of the process by which they will be answered? Can we then be confident in the action of the Monkey's Paw from which we have requested the grant of the £200?
>
> -Norbert Wiener, *God and Golem, Inc.* (1966, pg. 58)

Beginning at the End

Endings to narratives are often punctuated with provocative images, like the images of the dismantling of Berlin Wall at the beginning of the proverbial 'end of history' (Fukuyama 1989). Back then, handheld cameras depicted significant events on human scales from viewpoints familiar to human eyes: hands and tools at work, in action, unmaking both physical and political structures. Now we have drones, and the ultra-high-resolution images that announce the Anthropocene – the *end* of the Holocene, by human "hands" in the more abstract sense, are presented planometrically, without indication of relief, the observer hovering parallel to the subject plane. In muted tones, images of structures and industrial landscapes are flattened; the topography and elevation become indiscernible except where extractive processes have carved intuitive contour lines, as with marble quarries or coal ash pits. The Anthropocene's features appear pressed and stained under sheet glass to be viewed, frozen in time, out

of context, as if through a distant microscope. Perhaps what is most striking about the images of "manufactured landscapes" is how often they do not appear manufactured at all. They appear organic, and perhaps that was the photographers' intent.

The Anthropocene is exhibited and sold to its constituent populaces in its pop-culture imaginary. Now, we are both participants and observers of geological history. The two-dimensional, planimetric photographs depict processes that many will never experience first-hand, processes that are inexorably bound to techno-capitalist ways of being. These processes are obscured to us in both physical and conceptual terms, despite their being essential to how citizens of the techno-capitalist world live their lives.

Figure 1: Edward Burtynsky: Saw Mills #1, Lagos, Nigeria, 2016 (image source: Khatchadourian, 2016)

These images are arresting because they present us not with the processes themselves but with evidence of the reality that such processes actually occur. At the Anthropocene Exhibit at the Art Gallery of Ontario (Figure 1), I was struck by the visitors' reactions, varying from detachment to amazement to

incredulity. How did "we" let this happen? Why are "they" doing this to "us"? What can "we" do differently? Why aren't "they" doing anything about this? Implicitly, we are to ask ourselves a similar question as that prompted by a plaque at the Berlin Holocaust Memorial (see also Stein 1993[1]): is the Anthropocene an aberration perpetrated upon "us" by an aberrant "them"? Or is it a reflection of who "we" are and always have been (and always will be)?

In the fall of 2021, I taught a course in the "Economics for the Anthropocene" at York University. I began by gauging my students' familiarity with the core concepts. I asked who, among the seventy second-year, Gen-Z undergrads, was familiar with the concept of the Anthropocene. Encouragingly, most students raised their hands. I asked them who had heard of the Holocene: one or two hands. They knew *something* had come before, but they only had a vague sense of what it was or the length of its duration. For some, the Anthropocene concept was their first introduction to geological history. I asked my students another question at some point: who among them was experiencing "climate anxiety?" All hands. Their stories also began at the end.

Many scholars of environmental politics criticize the concept of the Anthropocene for various reasons (Malm and Hornborg 2014; Moore 2017, 2018), and I will discuss their concerns in due course. For now, I will only suggest that the Anthropocene has intellectual merit, at least insofar as it highlights a rhetorical departure within environmental discourse away from the essentialism of some earlier traditions in eco-philosophy. Increasingly, we are beginning to understand that through our activities, we are not "killing the Earth"; we are unintentionally precipitating yet another change in the much longer natural history of the planet's dynamic climate system[2]. The sustainability discourse is increasingly self-conscious of the fact that the existential crisis for "us" (the Anthropos) will engender climatic patterns that are perhaps comparable, in terms of habitability at least, to the conditions in which our ancestors evolved for untold millennia; conditions unfit for widespread, permanent

[1] From Stein, 1993, pg. 486: "Is the Holocaust an aberration of a particular culture, a particular time, or can it tell us about ourselves, everywhere? We should be reluctant to diminish its emotional size with our manageable theories."

[2] For my purposes, I use the term, Anthropocene, as a heuristic that denotes how anthropogenic activity is destabilizing the Holocene. I am not attached to or aligned with the idea that the Anthropocene is a distinct period in geological history. Furthermore, I oppose any suggestion that the Anthropocene was an inevitable outcome of any more general, indelible social, economic, or natural process including capitalism (as it pertains to Moore's competing term, the "Capitalocene"). Although I agree that the Anthropocene is not a result of the actions of the *Anthropos* (i.e., all humans as a collective), and that responsibility disproportionately lies with a small group of affluent global elites, I also resist the idea that the destabilization of the Holocene was an inexorable consequence of *capitalism*. That is, I do not find it inconceivable that" in an alternative history "the great acceleration" might have also resulted from centralized economic planning.

settlement. Of course, “we” don’t really want to live like that; besides, we wouldn’t know how to. An existential crisis for “us” is synonymous with an existential crisis for techno-industrial capitalism, which, like all human civilization, has only been possible within a brief window of the past ten thousand years. The artifices of human civilization owe their existence because a detached-yet-beneficent, self-organizing climactic pattern, stabilized by a complex web of non-linear living and non-living processes, emerged and took hold, persisting for eleven millennia, making agriculture and permanent settlement a possibility and then a reality. In many ways, our “place” is more situated in time than space, and we are no more “Earthlings” than the dinosaurs who would be unable to survive today’s atmosphere.

Climate denial, in effect, amounts to the notion that there is nothing techno-industrial civilization is capable of that could destabilize that fragile, self-organizing, non-equilibrium climate pattern. Of course, denial is irrational, but so are all the stages of grief. The stage after denial is anger, and it remains to be seen how that anger will find expression. There are hints, however. In the UK, a new movement dubbed the “Extinction Rebellion” has precipitated widespread calls for student strikes, general strikes, and even “birth-striking,” whereby women refuse to reproduce (Richardson 2020). What are we to make of such a reaction?

On the one hand, it would be easy to problematize such a move as reductive and patriarchal social Darwinism: a society that cannot adapt to its changing environment does not *deserve* to reproduce. The logic of extinction holds: if we cannot evolve, we will de-select ourselves from the evolutionary process. And yet, from anti-reductive, social and political, feminist perspectives, amidst the relentless assault over women’s health, reproductive rights, and bodily autonomy, birth striking also appears as “embodied protest,” akin to hunger-striking (Machin 2014a), or social disobedience, pointedly re-asserting the reality that all social and economic reproduction is ultimately contingent upon the bodies of women and the economies of care that woman are expected, and coerced through gendered oppression, to cultivate and manage throughout history (Katz 2001).

As the climate crisis intensifies and inaction becomes increasingly stale, the rhetoric from sustainability scientists becomes simultaneously more embodied and personal. While delivering the Stocktaking plenary at COP26, vice-president of the European Commission, Frans Timmermans, made the following appeal on behalf of future generations:

> This morning, or an hour ago, my son Marc sent me a picture of my grandson, Kees, who is one year old. I was thinking Kees will be 31 when we're in 2050, and it's quite a thought to

> understand that if we succeed, he'll be living in a world that's liveable. He'll be living in an economy that is clean, with air that is clean, at peace with his environment. If we fail, and I mean fail now within the next couple of years, he will fight with other human beings for water and food. That's the stark reality we face…. 1.5 degrees is about avoiding a future for our children and grandchildren that is unliveable. I might not reach 2050, probably won't. But he will be there as a young man, and I want him to live a peaceful prosperous life, like I want it for everybody's children and grandchildren in this room. This is personal. This is not about politics (Timmermans 2021).

Even assuming that Timmermans' sense of urgency is warranted and his desire for universal, peaceful prosperity is sincere, the relative political inefficacy of those who are sounding the alarm on climate change and other planetary boundaries (Rockstrom et al. 2009) may be attributed to, in part, to a failure to recognize that the "*end of the world"* is substantially more political than they might imagine. Indeed, it is difficult to imagine a climate apocalypse without invoking similar portents of doom in recent history, most notably the threat of nuclear war (Inwood and Tyner 2022). Most people alive when the Berlin Wall fell do not reflect often enough on how we were born and have continued to live in the shadow of the genuine possibility of imminent nuclear annihilation. How did we survive that end? In retrospect, the game theoretic, zero-sum equilibrium imposed by mutually assured destruction was assuredly more porous than military planners ever realized. We averted MAD through compromise, statesmanship, politicking, and luck. Now, the "Doomsday Clock" (figure 2) is closer to "midnight" (i.e., human extinction) than it was at the height of the cold war. Furthermore, although we look back on the early twentieth century with disdain, the reality is that the latter half-century - in the stability of the *Pax Americana* and the "end of history" witnessed more human death, particularly civilian death, resulting from conventional war and its ancillary consequences than that of the two world wars combined. For many in the global north the stark reality "we" face has been a stark reality "they" live out in the day to day lives; the multiform expressions of violence – dispossession, displacement, deprivation - that are unthinkable for "us" are ubiquitous for "them", and it is incomprehensible that the insecurities "we" have tolerated for others is a reality we would not subject our own children to. Many humans already live lives that are "unliveable," by Timmermans' criteria. If "we" were unable to provide a clean, peaceful, and equitable economy at the "best of times" (i.e., under conditions of unparalleled economic growth and development), then how will we succeed under the added challenge of ecological collapse? Anti-capitalist theorists, such as Slavoj Žižek (1994), Frederic Jameson (1994), and Mark Fisher (2009), warn that it is "easier to imagine the end of the world than the end of capitalism."

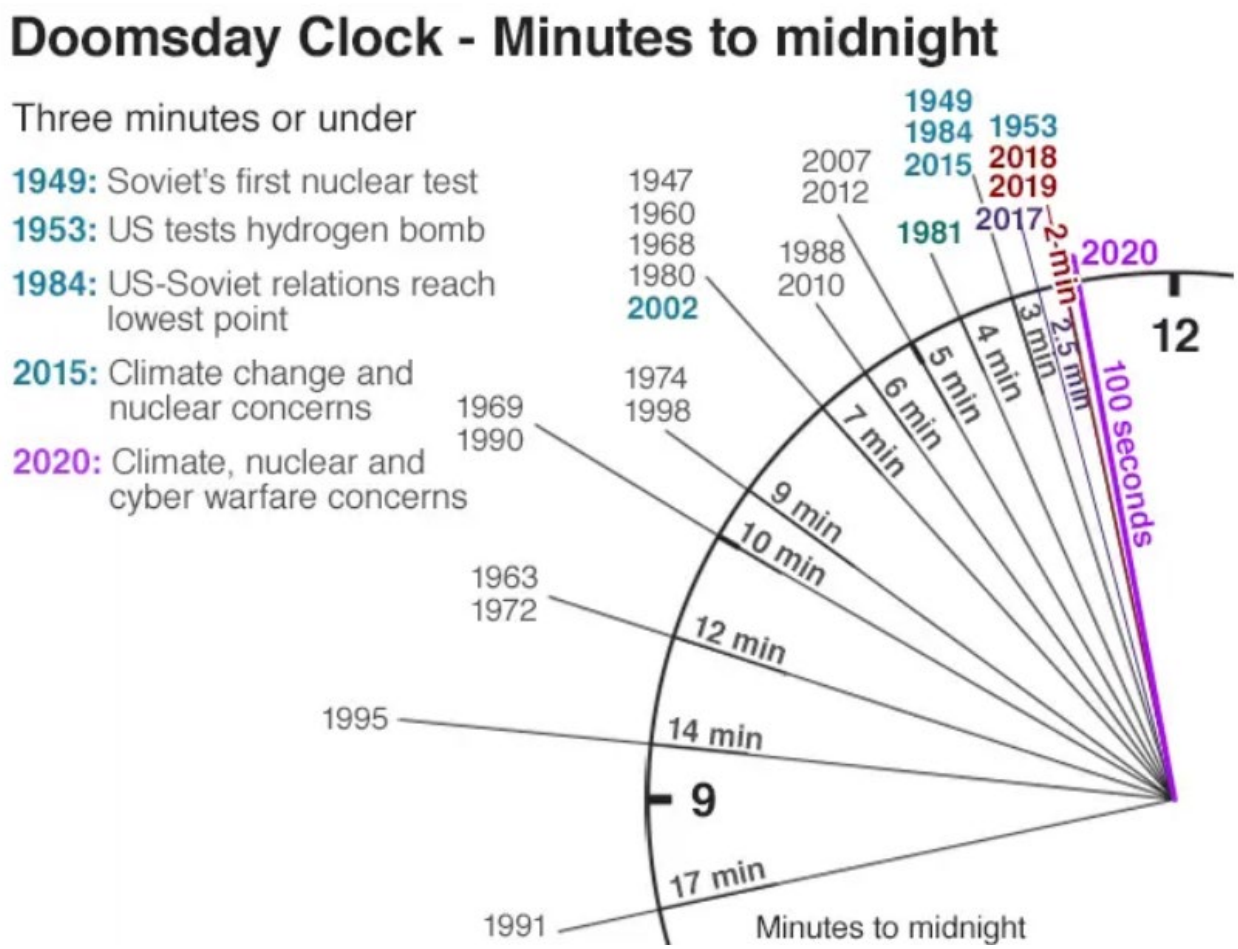

Figure 2: The Doomsday Clock, "a design that warns the public about how close we are to destroying our world with dangerous technologies of our own making. It is a metaphor, a reminder of the perils we must address if we are to survive on the planet" (Source: Bulletin of the Atomic Scientists, Accessed 2022. Image Source: BBC, 2020.

The concept of finality is inevitably tinged with cultural and spiritual affordances that tend to buck rationality. According to a 2019 Gallup poll (Brenan 2019), upwards of forty percent of Americans are Young Earth Creationists, believing that God created humans and the Earth in situ within the last ten thousand years. There is also demographic overlap between creationists and the emerging "doomsday prepper" sub-culture, prompting an emerging market in luxury fallout shelters. Intriguingly, the same proponents of climate denial are among the first to acknowledge that prolonged radioactive winter would undoubtedly result from a nuclear exchange between global superpowers. The question then is not whether the climate *can change* but rather *how* the climate changes and *what* could possibly affect

such a change. As ever, the efficacy of militarized violence is afforded a privileged position in modern imaginaries.

How, exactly, will humans go about going extinct? What will "fighting over resources" look like? The most obvious answer to both questions is war. According to the World Bank, the Syrian Civil War was likely the world's first climate war (Linke and Ruether 2021), as drought and subsequent famine prompted unrest and precipitated uprising against the Assad regime. In turn, the Syrian refugee diaspora is widely considered a catalyst for the return of reactionary right-wing politics in Europe and North America, as isolationist political propaganda capitalized on the unfolding human tragedy by propagating xenophobic narratives, warning of the impending "great replacement" and "the Fourth Turning" (Strauss and Howe 1997). As reactionary right-wing electoral successes mount, the rules-based global order of liberal hegemony appears to wane, possibly precipitating the resurgence of multipolar geopolitics. Russia's invasion of Ukraine, under the game-theoretic, geopolitical doctrine of offensive realism (Kleinschmidt 2019), threatens to exacerbate food and energy insecurity across the globe. In the age-old dictum of the banality of evil, Putin claims that Russia's geopolitical situation afforded only one degree of freedom: war. He had "no choice" but to do what he did. For Putin, as for the reactionary terrorist animated by coordinated misinformation campaigns, the end of the world is the end of *his* world: the end of euro-centric, patriarchal, heteronormative nationalism and the enduring promise of insular militarism. Chomsky has declared that we are entering "the most dangerous period in human history," in which very soon "the living will envy the dead" (Eaton 2022).

The corollary to the techno-apocalypse of nuclear war and climate disaster is the quasi-religious techno-optimism of eco-modernism. Across multiple social media outlets, amplified to an audience overmatching the wildest hopes of climate scientists and activists, the world's wealthiest men promote science fictional solutions to the crises of the Anthropocene. Geoengineering and carbon sequestration will mitigate climate change; renewable energy will provide clean and cheap power to everyone. If we fail, we will terraform and colonize mars. If we fail, we will upload our consciousnesses to supercomputers and live as immortals, immersed in virtual realities. Failing all those contingencies, we can take consolation in the fact that our universe is, in fact, a computer simulation.

Despite their techno-utopianism, Rushkoff (2019) details how the ultra-rich are quietly building their doomsday bunkers in anticipation of "the event" (whatever it may be). According to Rushkoff, "the Silicon Valley billionaire with an apocalypse bunker in New Zealand uses a similar logic to justify creating the very conditions that are leading to a world where such a "plan B" should be required. The smartest,

wealthiest technologist gets to survive because he won. It's a hyperbolic, digitally amplified, zero-sum version of the same exclusion" (2019, pg. 89).

What am I trying to say? First, those seeking to escape politics the most invariably escape it the least. As absurd as it may sound for some, the "end of the world" is not now, nor has it ever been, nor will it ever be, apolitical insofar as any impending catastrophe suggests clear-cut imputations to act in accordance with any one agenda (even one as intuitive as preventing human extinction). There are many worlds, and many worlds end every day. For climate scientists, the end of the world is an unimaginable impending catastrophe. For those in poverty, the end is contiguous with an existing reality; a fresh injury that only extends a longer history of exploitation, neglect, coercion, and abuse. For the neoliberal elite and for the religious fundamentalists they employ as "useful idiots," the end of the world is only an event; one, they imagine, that changes the nature of their power in relation to those they dominate but will not fundamentally disempower them.

Secondly, although I affirm that the perspectives of climate scientists and the marginalized majority are the only legitimate and morally defensible positions pertaining to the "end of the world," the more generic point I am promoting is that neither environmental justice nor sustainability science alone can resist the antihuman chimera of neoliberal hegemony, occidental triumphalism, military industrialism, hierarchical patriarchalism, social Darwinism, technocratic optimism, and aspirational fascism that inexorably generates and exacerbates the multiple and overlapping, human and non-human crises of the Anthropocene. Indeed, I attest that a significant contributing factor to our relative inability to imagine or realize alternative futures is the antipathy between the two respective discourses we must look to in search of new imaginaries, new narratives, and new possibilities.

From the perspective of environmental justice, what sustainability science has in common with each of the respective components of the antihuman chimera is the idea that there are absolute realities that supersede and legitimately displace the politics of decision-making. For many environmental justice scholars, sustainability science is implicated in the chimera through genealogical linkages involving intrinsically antihuman affordances, systems, cyborgs, automata and games. Conversely, for many sustainability scientists, environmental justice - insofar as it problematizes, and often dismisses, their allegedly "Malthusian" projections and objectivist political imputations - presents as a covert form of climate denial, one associated with decadent, narcissistic, pseudo-intellectual, obscurantist, post-modernists who are responsible for having sewed the seeds of the "post-truth" paradigm (Erickson and Brown 2016). The spectre of the "science wars" of the 1990s looms large as interlocutors posture for

visibility, priority, legitimacy, and authority. Implicitly we ask, is equity a precondition for sustainability, or must we first address sustainability before we afford ourselves the *luxury* of addressing injustice?

Of course, the narrative of epistemological conflict that I have sketched here unavoidably simplifies the reality of sustainability discourse. There are few, if any, ideal examples of "sides" arrayed neatly in lines with uniforms and standards declaring allegiances. In fact, in many ways, one might suppose that the opposite is true. In recent decades we have seen a robust rise in interdisciplinary, even transdisciplinary, literature on various interpretations and construal of pluralism, hoping to bridge Snow's "two cultures" (Snow 1961). New epistemological postures, such as postnormal science (Funtowicz and Ravetz 1993, 2003), complex realism (Harvey and Reed 1996; Reed and Harvey 1992), and new materialism (Alaimo and Hekman 2008; Coole and Frost 2010) have arisen to address precisely the need for integrated social and scientific analysis, quantitative and qualitative complementarity, deliberative democracy, and citizen-science.

Methodological pluralism is resoundingly affirmed in contemporary sustainability science discourse. However, methodological pluralism does not imply ontological pluralism, and increasingly, ontological antagonism is recognized as a substantial barrier to pluralist transdisciplinary inquiry. Following the "ontological turn" in social theory, contemporary discourses on democratic pluralism and its implications for the social natural sciences have significantly outpaced and, indeed, unsettled the grounds upon which many inter-disciplines and trans-disciplines have enjoyed a stable footing until recently. Increasingly, social theorists are challenging interpretations of pluralism as absolute inclusivity. Indeed, the radical democratic concept of pluralism promoted in this text does not subscribe to an "anything goes" conceptual free-for-all, nor does it subscribe to a Social Darwinian natural selection of ideas, whereby "good" models progressively outcompete bad ones (Norgaard 1989). Following Norgaard, methodological pluralism relies heavily on the assertion that "complexity" engenders "multiple perspectives." Indeed, the heuristic distinction between complicated and complex phenomena has proven useful in arguing there is very much that science can say with astonishing degrees of predictive certainty even if, as the saying goes, all models are, strictly speaking, "wrong". Is global warming occurring as a result of anthropogenic activities? Yes. Can we say with any certainty how the climate crisis will unfold? No, although we can confidently say it will be undesirable by almost any deontological or consequentialist ethical posture compatible with pluralism and equity. Science is often instructive but never entirely prescriptive when we are navigating the uncertain consequences of complex problems pertaining to complex system. How we draw these distinctions, however, and,

therefore, how we navigate the entanglements of the natural and the political depends heavily on how we make sense of the nature of complexity and how we make sense of our sense-making in light of complexity. This brings us to one of the central questions of this text: what is complexity, and what theory or theories underwrite the capacity for one concept to draw such critical distinctions?

Chapter 1: The Complexity of Complexity Theory

The concept of "methodological pluralism," which largely underwrites the identity of sustainability science as a postpositivist transdiscipline, was originally, and is still today, justified vis-à-vis the claim that researchers must attend to "multiple perspectives" in making sense of "complex systems" and the "complex problems" associated with them (Norgaard 1989). The issue is not that there are no explanations for what complexity is, does, means, or engenders; the problem is rather that there are many. Following Cilliers (Cilliers 1998, 2005, 2016; Cilliers and Nicolescu 2012), there are at least 52 non-equivalent definitions of complexity in use across dozens of discrete fields of inquiry. Crucially, not all interpretations of complexity lend themselves to epistemological orientations that affirm multiple legitimate perspectives, and those that do consistently vary in terms of what constitutes a "perspective" exactly (e.g., representational models, formal systems of inference, worldviews, or ways of knowing and seeing). Complexity scholars distinguish between algorithmic complexity, deterministic complexity, aggregate complexity, semiotic complexity, epistemological complexity, and many other discrete expressions of the concept. As a result, complexity presents as an ontological penumbra adrift within another, more vacuous, epistemological penumbra. As Mikulecky (2006) reflects, the field of "complexity science" is itself an expression of the complexity of science.

Is this an inherently undesirable situation, particularly from the "perspective" of transdisciplinary pluralism? Not necessarily. In the social sciences and humanities, constructivism, fallibilism, standpoint theory, post-positivism, intersectionality, situated knowledge, pragmatism, and critical realism (to name a few) are all unique and sometimes complementary perspectives on the general "limits" of epistemology. Insofar as all of these postures reject epistemological reductionism and oppose objectivism and absolutism, they are more-or-less compatible. And yet, each of those perspectives exhibits comparatively clear and concise conceptual boundaries that rely on transparent and well-defined epistemological assumptions and ontological commitments. Complexity, by contrast, is extensively polysemic. The term implies radically different meanings in various epistemological, technical, and operational contexts. Most perniciously, the conventionalization of the discourse in which the concept of complexity has most taken shape – i.e., the discourse of systems theory that has morphed into "systems thinking" – has had complicated consequences in that "thin" (i.e., monistic, positivistic, and, therefore, anti-pluralist) versions of complexity are used interchangeably with "thick" pluralistic conceptions of complexity; the former "thin" definition defending and legitimating

themselves in the name of the latter (thick) definition that the former implicitly undermines (Strand 2002). This is significant because "thick" and "thin" conceptions of complexity lend themselves to distinctly different onto-political interpretations and, therefore, normative imputations for governance, particularly where the multiple and overlapping human and non-human crises of the Anthropocene are concerned.

Frequently, systems theory (the "house" of complexity) is valorized in sustainability science as the key to, and source of, transdisciplinary pluralism (Norgaard 1989). Contrarily, sustainability systems theory is sometimes spurned among social theorists as an inexorable boundary to pluralism (Wellstead, Howlett, and Rayner 2017). Additionally, the unification of systems discourse has obscured these differences, and this, I attest, is an important source of social theorists' uneasiness with, or outright antipathy toward, systems theories and methods, particularly when applied to social and political systems. Furthermore, the conventionalization of complexity cuts both ways, as critique and purported purpose become matters of affect over rigorous discursive analysis. Proponents of systems approaches are prone to ontological claims that are often incongruous with the capabilities of their methodologies (Berlinksi 1978). Concurrently, critics of systems approaches are prone to overgeneralizing and constructing straw-man arguments by conflating the entirety of "systems theory" with whatever strand of systems theory the critic in question most opposes. As a result, critiques that suppress the "thick" pluralistic impulses present in many expressions of systems discourse are equally culpable in suppressing pluralism.

The resultant acrimony over complexity is counter-productive for justice and sustainability alike. Conventionalization means thoughtful contributions are often met with derision and suspicions, whereas meaningful and legitimate critiques are deflected or dismissed. Theories and methods that I will argue constitute "non-pluralist" expressions of systems theory (e.g., system dynamics or cellular automata) are commonly employed in sustainability discourse, and the limitations of such approaches must be widely recognized[3]. Conversely, subjectivist systems-theoretical approaches with robust, "thick" conceptualizations of complexity offer a range of methodological and conceptual tools that, I will argue, offer generative new potentials for environmental justice. If there is to be a pluralistic response to the crises of the Anthropocene, then the thick-thin duality of complexity must be addressed. A transdisciplinary, pluralist dialogue between environmental justice and sustainability systems theory

[3] Note that this list is non-exhaustive. Systems approaches that I consider "non-pluralist" broadly correspond to "functionalist" systems theories and methodologies according to critical and interpretive systems theorists (see Checkland, 1981; Jackson, 2000; Midgley, 2000).

cannot occur without a deeper and more granular understanding of the multiple meanings, usages, and genealogies of complexity.

1.3: Objectives and Caveats

By way of summary, I propose that the problématique presented thus far has the following components:

- A transdisciplinary, pluralistic exchange between sustainability science discourse and environmental justice is necessary and desirable because a) biophysical limits exacerbate distributional injustice and violence, and; b) injustice and violence exacerbate biophysical destabilization.
- Transdisciplinary, pluralistic exchange between sustainability science and environmental justice is prevented because sustainability science shares common, monistic ontological themes with both Spencerian functionalist and Hayekian neoliberal intellectual traditions[4]. Objectivist systems theory (based on "thin" conceptions of complexity) is the conduit that establishes ontological linkages between neoliberal hegemony and sustainability science.
- Anti-realist expressions of systems theory that rely on "thick" conceptions of complexity represent potentially fruitful avenues for pluralism between sustainability science and environmental justice, however;
- The conventionalization of the systems discourse itself collapses the difference between "thick" (i.e., anti-deterministic, anti-reductionistic, anti-objectivist) and "thin" (i.e., anti-humanist) expressions of systems theory, which serves to obfuscate the ontological commitments of sustainability science and, thus, preventing pluralistic engagement.

I will engage with this problématique vis-à-vis a modified version of the post-structural methodology of *genealogy*, which I will discuss in greater detail in chapter 3 of this text. Very briefly, following the post-structural philosopher Michel Foucault (1972), genealogy is a methodological "toolkit" for investigating how expressions of power (i.e., discursive practices) affect the formation of knowledge (i.e., discursive formations). The specific modality of genealogical inquiry that I am employing in this text – i.e., ontopolitical genealogy – follows after the contemporary post-structural political theorist William E. Connolly. As the name suggests, onto-political genealogy, unlike Foucault's genealogy, is centrally concerned with discursive practices that implicitly produce and reproduce social-political ontologies. The

[4] The reader will note that my usage of the term "neoliberal" refers specifically to the intellectual tradition following Friedrich Hayek and the Mont Pèlerin Society; what the economic historian, Phillip Mirowski, calls the "Neoliberal Thought Collective" (see Mirowski 2015; Mirowski and Plehwe 2009).

core objective of the onto-political genealogy found in this text is to destabilize the problématique of environmental pluralism and thereby provisionally establish terms for a new and more robust pluralism in environmental discourses (most notably, in and between sustainability science and environmental justice, generally represented in this text by ecological economics and political ecology respectively). To satisfy this objective, I argue for 1) a genealogy of conventionalized systems theory that re-asserts the differences between humanist and anti-humanist expressions of both systems theory and cybernetics[5]; 2) a genealogy of sustainability systems theory that identifies the discursive practices employed in instances where humanist and anti-humanist expressions are systems theory are conflated, and; 3) a counter-genealogy addressing critical accounts of systems theory in critical and post-structural environmental justice discourse to destabilize lines of similar confusion.

Some caveats first: this genealogical approach is not intended to exclude any parties from existing discourses. Furthermore, I do not seek to resolve existing conflicts between sustainability science and environmental justice. Rather, my purpose is to map both vectors of conflict and potential linkages between environmental justice and theoretical ecology, thereby delimiting the possible boundaries of ontological and methodological pluralism in ecological political economy (EPE). To that end, I affirm the efforts of both social and natural-science researchers operating within their respective epistemological modes. If I critique them on various points, it is not because I wish to undermine them; it is because I view reductionism as epistemologically inadequate and corrosive to democracy and equity. I interpret the project of anti-reductionism in science and social theory as perpetually recursive; it is impossible to finalize in principle. Reductionism, like racism, is more pernicious than the pervasively modern, liberal imaginary assumes; it hides in the folds of any claims that we have finally arrived beyond it. Following Connolly (Connolly 1991, 2009, 2013; Schoolman 2002), I will argue that anti-reductionism requires an "ethos of pluralization" that continuously unsettles settled ground. I affirm that no discourse is beyond the purview of genealogy, not systems theory, not its critics, and not this text.

Furthermore, these apologies should not suggest that I subscribe to both-sides-ism in the name of "fair and balanced" scholarship. I interpret pluralism as anti-anti-pluralism (Geertz 2008) and view objectivism, reductionism, and hegemony as anti-pluralist by definition. Good intentions notwithstanding, the desire to displace politics with naturalistic explanations ultimately reproduce the

[5] As I will explain in later chapters, "conventionalized systems theory" also inappropriately collapses systems theory and cybernetics. I will make explicit the differences and affinities between different the strands of each tradition.

logic of the same univocal, objective discourse of hegemonic neoliberal realism that proliferates the crises of the Anthropocene. As a heuristic rule, coercive, hegemonic power universally seeks to naturalize its ontology, collapsing any distinction between "is" and "ought." Hegemony relies on absolutist epistemological, ontological, operational, and moral postures; it derives legitimacy and constructs normalcy from naturalistic explanations. Contrarily, environmental justice discourse overwhelmingly derives its theoretical posture from intellectual traditions that overtly decry the nexus of objective discourse and technocratic managerialism.

To the extent that this text opposes neoliberal hegemony and, further, to the extent that this text employs a decidedly non-systematic method of discourse analysis generally associated with post-structural environmental justice, I am aware that it likely creates the appearance that my sympathies "lean" in that direction. I would reject such claims as missing the point; the "tail" of justice does not "wag the scientific dog" in this text. Rather, in the tradition of Cilliers, I am both a systems researcher and a post-structuralist, and I avow that there are instances in which the two are mutually supportive. Moreover, the "target" discursive object that this genealogy is intended to destabilize is the pervasive conventionalization of systems theory through *discursive practices* that serve to homogenize what was once a rich plurality of conceptual themes loosely bound together under the "systems" umbrella. Many critics and proponents of systems-socio-ecological systems theory alike rest their claims on partial readings of systems theory in which previously contingent statements and claims are universalized to the point of caricature. I believe that the resultant ambiguity is largely responsible for the notion that sustainability science suffers from "antagonism" or "uncritical pluralism" (Spash 2013). I ask the following: what remains when the "strawmen" (both for and against SST) are removed? What discursive practices perpetuate the conventionalization of sustainability systems theory? Whose agendas, if any, do these illusions serve? Who proliferates discord, and for what purposes, in the loci of sustainability intervention where distributional justice and sustainable scale are mutually relevant? If the current state of "uncritical pluralism" is untenable, how can the sustainability discourse achieve a more productive, inclusive, critical pluralism?

1.4: Scope and Structure

In Chapter 2, I elaborate on the theoretical context of this text by situating the problématique within a particular subset of the sustainability-environmental justice meta-discourse. Proceeding from the very general and expansive meditation on the problématique of complexity and justice, I situate this discussion within specific, highly relevant discourse(s) of sustainability science and environmental

justice. Moving forward, I will restrict my analysis to a more manageable subset of fields within those discourses that I attest most relevant to the problématique as stated. Accordingly, the field of ecological economics (EE) is presented as an exponent of the sustainability science discourse, whereas political ecology (PE) is presented as an exponent of the environmental justice discourse. I examine the prevalence of systems theories and methods within, and their application to, ecological economics by briefly reviewing EE's history and describing the relative impact that different systems concepts have had (or did not have) in shaping the EE discourse.

Ecological economics is comprised of competing genealogies, the most prominent of which are the Bioeconomic genealogy after Nicholas Georgescu-Roegen; the Co-evolutionary genealogy after Boulding's evolutionary economics; the biophysical economic genealogy after Howard T. Odum and his formal energy systems language; the ecosystem services genealogy after Costanza, which broadly incorporates complex adaptive systems theory, and; the "Social Ecological Economic" genealogy after analytical Marxism and critical realism. I identify four central genealogies in ecological economics: biophysical economics, co-evolutionary economics, socio-ecological economics, and the emerging discourse in social ecological economics. I review and discuss how each of the following genealogies approaches, interpret, enables, produces, and reproduces pluralism: 1) co-evolutionary economists (methodological pluralism); 2) biophysical economics (anti-pluralism); 3) social ecological economics (restricted pluralism); 4) socioecological systems ("intelligent" pluralism), and; ecological political economy (ontological and epistemological pluralism). I outline current debates around pluralism and emphasize recurrent conflict surrounding two key questions: 1) who ought to be excluded, and; 2) how or if ecological economics ought to recenter social justice as a core concern.

I examine the discourse within and between ecological economics and political ecology, whereby ecological economics is the exponent of sustainability science, and political ecology is the exponent of environmental justice. I will also discuss the emerging discourse of ecomodernism as an exponent of the techno-capitalist hegemony that I oppose (further note that both ecological economics and political ecology reject ecomodernism in equal measure). I argue this subset is appropriate because, as I will demonstrate, ecological economics relies heavily on theoretical systems ecology and political ecology, as a discourse, emerged in direct opposition to the application of theoretical ecology in the fields of cultural and social ecology. I review the history of critiques against the use of systems ecology within social theory in general, and I contrast them against contemporary critiques against, for example, the

use of resilience thinking, social-ecological systems theory, biophysical economics, and complex-adaptive systems in application to social and political theory.

I discuss how these genealogies employ different interpretations of systems concepts, such as emergence, holism, non-linear causality, self-organization and complexity. I review how these concepts feature within these genealogies and find expression in their respective interpretations of pluralism. Notably, I explain how these genealogies rely on conventionalized, under-defined systems concepts that obscure the normative implications associated with "fuzzy" ontological commitments. I argue that conventionalized concepts and fuzzy ontologies create the illusion of barriers to pluralism where there ought to be none and concurrently create the illusion of pluralism where it does not exist. I conclude that calls for unity within ecological economics manifest in implicit dismissals of legitimate criticisms of ecological economics and the exclusion of fugitive voices that are sub-alternated by the ontological commitments perpetuated within ecological economic discourse, where calls for unity obscure injuries and legitimate critique.

Having established the existence of multiple barriers to pluralism between ecological economics and political ecology, I provide an account of potential vectors of engagement between certain genealogies in ecological economics and the antihuman chimera sketched prior. Once again, I focus on theoretical affordances that displace political contestation and claim objective rules for economic systems that are exogenous, and prior to society, culture, and politics (e.g., biophysical economics). Once again, to be very clear, the purpose here is not to problematize ecological economics. Rather, I warn against the ways in which systems-theoretical concepts employed within ecological economics could potentially be – or, in some cases, has already been - appropriated, adapted, and co-opted to served problematic narratives and agendas. The purpose here is not to condemn ecological economists, but to forewarn them so as to inure their ideas against misuse.

Finally, this intervention calls for recognizing ecological political economy as a separate and distinct discourse rather than proposing another schema for reorienting ecological economics. I conclude this chapter by highlighting numerous scholars, such as Nicholas Georgescu-Roegen, Kenneth Boulding, Katharine Farrell, James Kay, and Alf Hornborg, whom I argue exemplify the "agonistic respect" necessary to build a robust discourse in a multi-faceted, pluralistic ecological political economy insofar as they challenge disciplinary and discursive norms within both EE and PE. Building on these previous scholars, I forward my own interpretation of EPE as a transdisciplinary discourse in environmental theory that combines radical democratic pluralism and humanist (i.e., thick-anti-reductionist) systems-

ecological theory with critical and post-structural accounts of environmental justice and anti-authoritarianism.

Having established the necessity for shifting the emphasis toward a new discourse in ecological political economy, Chapter 3 returns to the issue of pluralism itself. I explain how EE pluralism, in all its forms, is ill-equipped to affect a pluralist discourse between sustainability science and environmental justice due to a common inability to accommodate ontological pluralism. I review the ontological turn in political philosophy, which has resulted in the recentering of ontology and ontological pluralism in discussions of pluralistic democracy, the philosophy of science, and international relations. I explain how contemporary radical democratic theorists, such as Honig (Honig 1993), Mouffe, and Connolly (Connolly 1993b, 1993a, 2013, 2017), extend the concept of pluralism beyond its prior conceptions in democratic theory, namely: equilibrium democracy (Schumpeter), developmental democracy (Dewey) and deliberative democracy (Habermas). Contrary to the consensus-based deliberative democratic theory, the so-called "agonistic" radical democratic theorists emphasize the intrinsic value of political contestation that consensus-oriented political theory seeks to eliminate through assimilation.

Following Connolly, I introduce the distinction between arboreal and rhizomatic pluralism. I explain how the implicit tensions within EE and between EE and PE are due to ignored incompatibilities. I problematize all four proposals for EE pluralism, and I argue that it is necessary to tease out implicit ontological commitments and delineate points of conflict both between the genealogies internal to EE and between those genealogies and traditions outside of EE discourse (namely, political ecology, social ecology, critical geography, etc.). Specifically, I argue that implicit linkages between the genealogies of EE and the numerous genealogies of systems theory and cybernetics must be made explicit so as to demonstrate how EE has inherited many of the problematic conflicts of those earlier discourses.

I outline Connolly's onto-political approach to genealogy and describe how it diverges from Foucauldian genealogy whilst maintaining an ontology of pluralization that Connolly distils from a range of politico-philosophical orientations emerging out of what Connolly dubs the "minor tradition" in continental philosophy, which includes Nietzsche, Bergson, Whitehead, Foucault, Deleuze, Guattari, and Derrida. I explain how Connolly's onto-political approach entails a "double re-entry" whereby genealogical critique entails "reading for silence" so as to disclose implicit ontological commitments and, therefore, onto-political interpretations associated with the discourse under examination. According to the critical engagement, Connolly's onto-political genealogy, I explain, then involves a normative assertion of one's ontological commitments by "working on" i.e., re-formulating problematic ontological commitments

and re-imagining them in generative ways. To that end, Connolly's political philosophy serves multiple functions in this text, both methodological and theoretically normative. In addition to describing the methodology of onto-political genealogy, Chapter 3 reviews Connolly's political philosophy (i.e., the Politics of Complexity) along with its various components, including ontological commitments (i.e., relational holism, pluripotentiality, teleodynamism, and the protean diversity of being), epistemological assumptions (imminent naturalism, reflexive equilibrium, and critical responsiveness), and axiological judgements (entangled humanism, presumptive generosity, and agonistic respect).

Finally, I argue that Connolly's Politics of Complexity represents a fruitful and much-needed new addition to a comparatively small tradition of post-structuralist scholars engaging meaningfully with systems theory and theoretical ecology. Previous luminaries in this tradition include Paul Cilliers, a post-structural philosopher who established strong linkages between complexity and deconstruction, and Niklas Luhmann, the conservative systems sociologist whose autopoietic theory of social systems was vociferously opposed by social justice activists in the 1970s. I bring Connolly and Cilliers into conversation, but I ultimately critique all three theorists on similar grounds as my critique of ecological economists. That is, they all have a tendency of crossing genealogical lines when discussing complexity and other related systems concepts. Of the three scholars, Cilliers was the most aware of this, and in his critiques of Luhmann and chaos theory, we can begin to align parallel distinctions between humanist and anti-humanist systems theory, strong and weak post-structuralism, and "thick" and "thin" complexity. I argue that Cilliers distinctions are implicit within Connolly's political philosophy, and I figuratively put the two of them to guard the gates of my proposed vision of a multi-faceted, pluralist discourse in ecological political economy against reductionists and anti-pluralists.

Having set my established a theoretical foundation and having laid out my objectives (i.e., a methodologically and ontologically diverse discourse that sets up ecological limits and distributional justice as concurrent and entangled rather than subalternated concerns) in Chapters 1-3, the remainder of the text will deploy Connolly's onto-political genealogy approach, split evenly between its critical and normative modes. Chapters 4 and 5 deploy the critical mode to demonstrate how many of the genealogies of ecological economics rely on conventionalized systems theory to assert ontological distinctions between economics and ecology that do not exist. Building on Mirowski, I examine the epistemological and ontological entanglements between neoclassical economics, neoliberal economics, functionalist sociology, systems theory, and theoretical ecology. I assert that both neoclassical economic theory and cybernetic theoretical ecology have similar roots in the energetic evolutionism of Herbert

Spencer's functionalist sociology. In doing so, I thus begin my assault on the conventionalization and homogenization of systems and cybernetics by distinguishing concurrent systems traditions that are not genealogically linked to structural functionalism. To do this, I supplement Foster et al.'s (Foster, Clark, and York 2010) distinction between idealist and materialist forms of holism with Connolly's concept of "relational holism" to differentiate between functionalist (i.e., anti-humanist) systems ecology (rooted in Spencer) with the distinctly structuralist (and humanist) systems and cybernetic theories of Bertalanffy, Wiener, and Prigogine (all rooted in speculative naturalism and process metaphysics). Further, I explain how the humanist current in systems theory is not implicated in functionalism, social Darwinism, environmental determinism, and neoliberalism.

I conclude in chapters 5 and 6 by expanding Connolly's political philosophy and engaging it with a more contemporary humanist genealogy within systems ecology. I argue that this genealogy, building on the earlier humanist tradition in systems theory, can accommodate biophysical limits and environmental justice concurrently through a relational ontology that disavows both realism and relativism. Until now, this genealogy has never been articulated as a discrete discourse; thus, it has no name. I will descriptively refer to this genealogy as the "anti-neo-Darwinist" or the "new organicist" genealogy. It's members include but are not limited to: Robert Rosen, Don Mikulecky, James Kay, Eric Schneider, Robert Ulanowicz, and Stanley Salthe. I explain that this genealogy relies on a thick, semiotic concept of complexity and relationally reflexive concepts of holism that uniquely lend themselves to radically pluralist, anti-deterministic, and radically relational interpretations of living systems.

Accordingly, bringing Connolly's ontology into conversation with the Neo-organicist genealogy accomplishes two things: 1) I answer Connolly's critics - who point to Connolly's reliance on under-specified, generalized conceptions of complexity – by identifying a specific concept of complexity (i.e., Rosen's relational complexity) that aligns with Connolly's philosophical program; namely, Connolly's reliance on the concept of teleodynamism; 2) I argue that the neo-organicist genealogy provides more appropriate alternatives to the systems-theoretical concepts that Connolly currently employs (e.g., autopoiesis and complex adaptive system). Finally, I demonstrate how replacing certain conceptual features of multiple anti-humanist systems theories - namely those of Friedrich Hayek, Edward Banfield, and Niklas Luhmann) with corresponding concepts from neo-organicism results in defusing perniciously problematic elements of those theories. I conclude by arguing that Connolly's ontology, bolstered by neo-organicist systems theory, provides a strong foundation for a new, radically relational, multi-faceted, pluralist, transdisciplinary approach to ecological political economy.

Chapter 2: Ecologies of Economism

> Among Ken's delightful aphorisms my favorite is "Things are as they are because they got that way." On some reflection, one appreciates the profundity of this apparently inane remark. It is a bold challenge to conventional wisdom, according to which (if one takes a close look at it) "things are they way they are, because that's the way they are."
>
> -Anatol Rapoport, *Memories of Kenneth Boulding*
> (Rapoport, 1997, p. 426)

2.1: What is Ecological Economics?

Ropke's article, *The early history of modern ecological economics* (2004), asks: "Is ecological economics a transdiscipline, a new paradigm; something different from environmental economics or, rather, a part of environmental economics, etc.; open for anything with a relation to the environment, or something more?" The answer to these questions depends on who you ask, and invariably, whenever definitive answers are given by critics or proponents of ecological economics, those answers express normative statements disguised as descriptive ones. There is no "true" description of ecological economics, and the answer as to what ecological economics *is* invariably will depend on what individual ecological economists believe EE ought to be. If ecological economics should be a discipline, then EE is not a transdiscipline; if it is a new, heterodox paradigm, then it is not a "part" of orthodox, environmental economics, and so on. Additionally, any discussion on what EE is or ought to be involves implicit imputations as to who and whose perspectives ought to be excluded or marginalized. In general, this means that the history of EE is also implicitly laden with subjectivities, agendas, and ideologies. Nonetheless, Ropke's account does contain at least one unambiguous truism with respect to the EE discourse:

> The basic observation in ecological economics is banal and difficult to disagree with: the human economy is embedded in nature, and economic processes are also always natural

> processes in the sense that they can be seen as biological, physical and chemical processes and transformations. However, the implications of this statement for the study of human societies and economies are not banal. The basic idea of what becomes ecological economics is that the economy ought to be studied also, *but not only*, as a natural object, and that economic processes should consequently also be conceptualized in terms usually used to describe processes in nature (emphasis mine).

The first half of Ropke's statement is difficult to oppose. The latter half, however, contains a revealing qualifier - "*but not only*" - that situates Ropke's position amongst the broader spectrum of ecological economists. This qualifier suggests that it is universally accepted that EE ought not to be naturalistic, and this view is contestable (and, indeed, contested). Different groups provide alterative accounts of what constitutes "natural" objects and processes, and, as I will discuss, biophysical economists, for example, view the economy as a wholly natural process that is determined by immutable biophysical principles and laws governing social evolution. On the other hand, many ecological economists, including those who claim an affinity with political ecology, distrust and resist the naturalization of economic theory. Accordingly, different groups of ecological economists can be identified according to how they prioritize the natural versus the social. For example, Daly's "three pillars" of ecological economics assert that EE is concerned with sustainable scale, efficient allocation, and just distribution concurrently, but he also places "just distribution" as a lesser priority compared to sustainable scale. The difference between this perspective and Ropke's is the different between thinking of the economy as "primarily" a natural object as opposed to "also" a natural object." These differences may appear minor, but, as I will demonstrate, their implications are substantial.

Here, I will forego an attempt to provide a history of ecological economics, nor am I interested in promoting my own vision of what ecological economics ought to be[6]. Rather, my objective is to portray ecological economics as a discourse constituted by the acrimony that renders it not only resistant to definition but also fundamentally incapable of "deep" pluralism in its current form. To that end, this chapter reviews and critiques five impactful perspectives on pluralism and democracy within ecological economic discourse: co-evolutionary ecological economics (Norgaard 1989); biophysical economics (Hall 1988; Hall, Lambert, and Balogh 2014; Melgar-Melgar and Hall 2020); social ecological economics (Spash 2012, 2013), and; environmental pragmatism (Costanza 1998, 2019, 2020; Daly and Farley 2011). I then juxtapose each of these four perspectives against a final position that calls for the recentering of social

[6] I will, however, promote a vision of ecological political economy

justice as a core concern in ecological economic discourse (Spencer, Perkins, and Erickson 2018), in addition to the integration of ecological economics and political ecology (Kolinjivadi 2019). I do not claim that the four perspectives I have chosen adequately represent the full range of possible or existing perspectives within the pluralist debate in ecological economics. Rather, I have selected these perspectives because they all rely heavily on concepts relating to systems and complexity, and, as such, they are relevant to the broader discussion of this text.

I discuss how each of the first four perspectives precludes the last perspective in their own unique ways. In general, however, all five perspectives share a theoretical reliance on conventionalized, over-generalized, and under-theorized interpretations of complexity and systems theory. As I will explain, because ecological economic pluralism is generally presented in terms of conventionalized systems theory (i.e., interpretations of systems theory that collapse the significant ontological differences between the various, disparate strands of systems research), ecological economic pluralism uniquely excludes perspectives that are critical of many, if not most, expressions of complexity and systems theory, including many essential discourses that constitute the broader discourse of environmental justice more generally (e.g., critical geography, political ecology, and social ecology). In addition, I show that the conventionalization of systems discourse in ecological economics privileges a specific subset of the systems discourse whilst ignoring others (e.g., critical systems theory).

The first half of this chapter reviews the four perspectives on pluralism in their own words and without prejudice. Here, the focus will be on identifying problematic statements and trends rather than offering perspectives on how to address them. The second half of this chapter briefly outlines the extensive history of critique against the application of systems theory in various disciplines. I then connect that history to contemporary discord between sustainability science and environmental justice and, in so doing, demonstrate how various proposals for pluralism in ecological economics are untenably restrictive and inherently incommensurate with environmental justice discourse, thus precluding the possibility of centring justice as a pillar of EE.

2.2 Economic Ecologism or Ecological Economism?

The term “ecological economics” first appeared in 1987 with Joan Martinez-Alier’s 1987 book, *Ecological Economics: Energy, Environment and Society.* Shortly thereafter, the International Society for Ecological Economics (ISEE) was founded in 1989, alongside the founding of the Journal of Ecological Economics in 1991. It should be noted, however, that although Martinez-Alier’s 1987 text was the first ever to include “ecological economics’ in the title, that should not suggest that the subsequent discourse of EE

coalesced around the agenda and concerns articulated by Martinez-Alier. Rather, in his own words, the text, *Ecological Economics,* was intended to serve as a *history* of the precursors and contemporaries of Nicholas Georgescu-Roegen, who is considered by many to be among the foremost "forefathers" of the contemporary discourse of ecological economics. As a historical text, *Ecological Economics* covers the intersections between ecology and economic theory in the period immediately after the discovery of thermodynamics up until the early 1940s. However, these intersections, explains Martinez-Alier, are both diverse and diffuse, and his narrative points to "a lack of social atmosphere before 1973, inside or outside the academic world, for the formation of a school of ecological economics" (Martinez-Alier, 1987, p. 3). Critically, this means that the first book on "ecological economics" was actually retroactively applying the term to a select and disconnected group of scholars who were either economists engaging with the question of social energetics (e.g. the Ukrainian socialist, Serhii Podolinsky), or natural scientists who engaged with political economy (e.g., Ostwald, Frederick Soddy, Josef Popper-Lynkeus).

I will not summarize the positions of Martinez-Alier's "protagonists," but for this section, I wish to highlight that Martinez-Allier's account points to a set of shared features between them: 1) a broadly socialist political economy; 2) an epistemological posture that follows, or is at least closely compatible with, the logical empiricism of Otto Neurath; 3) a predilection for social energetics, and; 4) anti-neoliberalism (note that Frederick Hayek and Karl Popper disdained all for their alleged physicalism, scientism, and implicit authoritarianism). Another quality that Martinez-Alier's "protagonists" share is a relationship to ecology that most ecologists consider peripheral at most, despite his insistence that this is due to oversight and that his authors should rightfully be regarded as significant influences on ecology, human ecology and ecological anthropology. These claims, however, speak to a curious circularity and internal tension in *Ecological Economics* (i.e., the text) as well as the contemporary discourse in ecological economics. In the introductory passage, Martinez-Alier defines ecology as a field that "studies the flow of energy and the cycles of materials in ecosystems" (Martinez-Alier, 1987, p. 1), and he establishes "the use of energy" is "the central point of ecological economics" (ibid). And yet, wherever in the text Martinez-Alier directly engages the application of ecological energetics, he is consistently circumspect. He rejects Lotka's social energetics as social Darwinism; he rejects functionalist ecological anthropology; he rejects the "line of filiation from Malthus to social-Darwinist ecologism"; he disdains Hardin's "Lifeboat Ethics" (Hardin 1974) as quintessential social Darwinism; he diplomatically refuses to reject human ecology, but he ultimately insists that economics "should not be reduced to human ecology."

These considerations are important because they establish that the "ecological" aspect of Martinez-Alier's interpretation of ecological economics carries an array of implicit asterisks, contingencies, and caveats that were never universally adopted by many, if not most, of those who would later call themselves ecological economists. Rather, Martinez-Alier's text affirms a particular view of ecological economics that concerns the intersections of *social energetics*, economics, and society. The "ecological" in his interpretation of ecological economics denotes an affinity, *but not correspondence*, between social energetics and the distinctly normative, ecosystems-ecological interpretation of ecology as the study of flows of energy and the cycles of materials in ecosystems (an interpretation, it must be stated, that many ecologists – particularly community ecologists – distrust if not oppose). The critical takeaway from this discussion is that, as Martinez-Alier initially interpreted it, ecological economics was intended to resist *both* ecologism and economism.

At this point, it is worth addressing that the ideological, ontological, and epistemological divisions in *contemporary* ecological economic discourse are highly correlated to geography. Without discounting the plethora of talented scholars who have contributed to the European community of ecological economists over the years, I believe it is fair to suggest that Martinez-Alier is a central figure who helped establish the identity and agenda of European ecological economics. Broadly, the European tradition gravitates around but is not dogmatically adherent to the concerns and interpretations of Martinez-Alier concerning the relative weight of ecology versus economics (or, more generally, natural versus social theory). As a cursory demonstration of this trend, one only needs to look at how the regional scholarly societies for ecological economics represent themselves. From the "about us" section on the ESEE website:

> Proponents of ecological economics in the initial years have, sometimes, tended to neglect the socio-cultural and political dimensions of economic development and change, while focussing on the biophysical analyses of phenomena. The starting point of the ESEE is recognition that economic activities are embedded in and dependent upon the ecosphere. It is necessary, however, to move beyond the simple recognition of biophysical limits to economic growth, in order to explore how, in what ways, and to what degrees the socioeconomic objectives traditionally associated with growth can be reconciled with concerns for environmental quality and preoccupations with social justice and variety of cultural forms (*About ESEE: The Social Dimension of Ecological Economics*, Accessed 2022).

This passage is reminiscent of Martinez-Alier's position as well as that of many, if not most European ecological economists. It suggests that there is overlap, but not direct congruence, between ecosystems ecology and economics. By contrast, the "about us" link on the International Society for Ecological Economics website provides no statement and instead opens to a page outlining the "History of ISEE" That page features a photograph (figure 3), taken in 1990, of a workshop preparing the inaugural ISEE conference proceedings, under the headline "Ecological Economics: the science and management of sustainability." The image is a veritable "who's who" of impactful thought leaders in EE discourse (and, in observing this, one should note both the obvious gender imbalance, as well the disparity in ethnic representation between researchers from the global North and South). Some scholars in the image, such as Robert Ulanowicz, directly engaged only briefly with the society and subsequent journal of ecological economics. Others, such as Daly, are broadly considered by many nearly synonymous with ecological economics itself. In the back row, standing behind Daly, is Garret Hardin, whom Martinez-Alier two years prior had criticized as an exponent of social Darwinian ecologism.

Figure 3: Photograph appearing on the "About Us" section from the International Society for Ecological Economics website. According to the website, this "classic photo" from 1990 depicts participants from a workshop held on Wye Island, Maryland. The purpose of the workshop was to prepare the introduction to the first ISEE Conference Proceedings, "Ecological Economics: the science and management of sustainability"' (https://www.isecoeco.org/about/).

This remarkable image speaks volumes about the inherent, in-built tensions and contradictions that were present from the beginning of the ecological economics discourse (and, indeed, before the "beginning" because EE inherited these tensions from earlier discourses in environmental sociology, cultural ecology, and environmental anthropology). Hardin was not only a social Darwinist, as Martinez-Alier had alleged, he was also an anti-pluralist in the cultural and political sense who considered multi-ethnic society a form of social "insanity" whereby "open immigration policies" collectively constituted a form of "passive genocide" against whites. To illustrate this point, The Southern Poverty Law Center (SPLC), one of the United States' preeminent civil rights legal advocacy organizations, explicitly considers Hardin to have been a white nationalist, and they maintain a profile on him in their extensive database of both historical and current ethno-nationalist operatives. In partial support of their claim, the SPLC points to the following passage from Hardin's '91 article in the far-right nativist magazine *The Social Contract*:

> Promoters of more diversity maintain that the more immigrants the better; and the greater the variety the richer America will become. Many of these promoters are "Europhobic"--fearful of, or revolted by, European civilization and values. They say we should stop taking in North Europeans, urging us instead to solicit the Filipinos, the Taiwanese and the Salvadorans. "And why not more Sikhs, more Turks, more Somalis, more Chileans, more Maoris, more Ibos, and more Malaysians?" …
>
> The answers to these questions should be beyond dispute. Diversity is the opposite of unity, and unity is a prime requirement for national survival in the short run. In the long run, beliefs must be susceptible to change, but massive immigration is a dangerous way to bring about change in ideas and practices. To nurture both unity and progress a double policy should be embraced: *Great diversity worldwide ; limited diversity within each nation* (Hardin, 1991, p. 137, 138).

The implications of Hardin's involvement at the inception of the EE discourse are twofold: first, it demonstrates that ecological economists were unwilling to exclude Hardin despite his having been problematized by one of their foremost theorists only three years prior (Martinez-Alier is pictured in the far right of the same frame). EE pluralism, in other words, clearly extended to anti-pluralists as well, but such a decision would have been unremarkable in the context of liberal scholarship in the late 1980s. Hardin was a respected ecologist and environmentalist well known for *The Tragedy of the Commons* (Hardin 1968), and it is easy to understand how he would have been considered a voice worthy of

inclusion despite his xenophobic views (which were not common knowledge at the time, even among his peers). His presence, in and of itself, does not implicate the other workshop-goers. Still, it provides insight into how early ecological economists struggled to reconcile their eco-social ontologies with concepts of disciplinary pluralism and multi-ethnic, multi-cultural democracy.

Pluralism in ecological economics as well as other fields that straddle both natural and social theory (e.g., environmental sociology), is a fraught territory in part because ecology, in part, concerns the function and essential value of diversity itself. Indeed, any social and political theory concerning cultural, social and political pluralism must unavoidably engage with, and often counter, naturalistic interpretations of ecological and evolutionary theory and their alleged implications for social theory – sociobiology continues to press this debate in mainstream forums. Ecological economics, in other words, has inherited these tensions from much earlier debates on the role of naturalism in social theory. One will note, for example, that Hardin's rejection of multi-culturalism is offered in the context of an article that purportedly prescribes how diversity ought to be "nurtured," his views informed by his own distinctly cybernetic theorization of ecosystems ecology[7]. In other words, Hardin opposed social and cultural pluralism in the name of genetic diversity because he viewed human society in primarily biological terms.

The specifics of Hardin's ecology will be dealt with in later chapters, but for now, the broader point I aim to address is that Hardin maintained an "ecological" worldview, and this should serve to illustrate how the term "ecological" should not be uncritically invoked in a normative sense. Hardin's interpretation of ecology informed his social, political, and ethical positions; his social ontology. Critically, the same can be said for many ecological economists then and since, even among those who firmly reject Hardin's conclusions pertaining to the implications of ecology for society.

2.3: The Pluralism Debate in Ecological Economics

From this discussion, I will provisionally separate modern ecological economists into three rough categories, differentiated according to the degree of overlap and/or correspondence between natural and social theory[8]:

[7] This counter-intuitive position is echoed by contemporary white nationalists who promote universal ethno-nationalism in every country.

[8] A caveat: some ecological economists (e.g., Costanza) shift between these groups depending on the subject at hand.

1. Social bioeconomics: who insist upon the indisputable relevance of - in addition to an affinity, but not equivalence, between - social energetics and ecological biophysics to the economic process. Georgescu-Roegen, Martinez-Alier, and Martinez-Alier's protagonists (e.g., Soddy, Ostwald) were prototypes for this group.
2. Biophysical Economism: those who regard social and ecological energetics as isomorphic. Odum was the progenitor of this group.
3. Ecologism: those who view human social, political, and economic processes as governed by ecological processes beyond those that are reducible to energetics (e.g., evolutionism, resilience thinking, and ecological complexity). This group includes Hardin, Costanza, Holling, Norgaard, Rees, and Boulding, among others.

The first group rejects the premise of the latter two, although it pragmatically will adopt certain methods to illustrate the inescapability of the biophysical dimension of social and economic affairs. The second group is the radical extension of the third group, the difference being that while the second group adopts naturalistic explanations, they view biophysics as the essential basis driving all ecological processes. The second group either tolerates, ignores, or attempts to subalternate the first group. The third group is too diverse to offer general statements regarding their relations with the other two. Overwhelmingly, their social and political postures relative to the other groups depends on the normative implications and ontological commitments stemming from particular theories or theorists' interpretations of theoretical ecology. As discussed, Hardin interprets theoretical ecology as an imputation for ethnonationalism. Conversely, Norgaard, who also promotes a naturalistic and evolutionary social ontology (inspired in part by Boulding), interprets ecological theory as an imputation for pluralism. As a result, group one disdains naturalistic explanations and clearly opposes social Darwinism, but it will also provisionally entertain ecologism when ecological theory aligns with their social-theoretic postures.

There is also a fourth group: those who apply orthodox economic theory in the pursuit of ecologically desirable ends. This group includes environmental economics and ecosystem services. Indeed, the concept of payments for ecosystem services was the spark that lit the recent debate over pluralism in EE over the past decade, a debate that is primarily concerned with the question of whether to exclude ecosystem services from EE and relegate it to environmental economics. *This is not a debate I wish to*

engage with extensively in this text[9]. Rather, there are other, in my view, conspicuously overlooked facets of pluralism in ecological economic discourse that are also, if not more, worthy of consideration. Indeed, in the debate over ecosystem services, I believe that the most vocal arguments either for or against PES often subtly obscure more extreme normative assertions that potentially carry expansive consequences beyond the borders of EE's discursive spaces. The ecosystem services debate is indicative of a proxy struggle between conflicting worldviews. To that end, this chapter will conclude by interrogating each group's position within the pluralism debate in search of subtle discursive practices intended to delimit or expand the boundaries of what constitutes acceptable ecological economic discourse.

2.3.1: Getting Beyond "getting beyond the argument culture"

Costanza is at once a unifying and divisive figure in ecological economics. As the original and longest-standing- editor-in-chief of the Journal of Ecological Economics, an ecologist by training and a former student of Howard T. Odum, Costanza's disciplinary orientation is firmly rooted in the natural sciences. And yet, he is a figure of controversy within the EE epistemological community precisely for his endorsement of orthodox economic methodologies such as payments for ecosystem services and natural capital (Costanza et al. 1997). In the inaugural issue of The Journal of Ecological Economics, Costanza puts forward his own vision for the trajectory of ecological economic discourse.

> Ecological Economics addresses the relationships between ecosystems and economic systems in the broadest sense. These relationships are the locus of many of our most pressing current problems (i.e. sustainability, acid rain, global warming, species extinction, wealth distribution) but they are not well covered by any existing discipline… Ecological Economics will, in the end, be what Ecological Economists do…. A fair amount of space in the journal (especially in the first few years) will be devoted to introspective discussions of what the field is or should be, its historical roots, and where it is going or should be going (Costanza, 1989, p. 2).

[9] I will only add that I do not view pluralism as a matter of purity, and I am inclined to side with those who are against excluding the fourth group on basis that history shows many examples of the oppressed resisting or overturning injustice by adopting the ways, but not the oppressive worldview, of their oppressors. I am willing to entertain the possibility that the ends sometimes justify the means if we are able to resist the implicitly unjust ethos that underwrites the latter; and, if we are able to promptly able and inclined to dismantle the means if and when the justifiable ends are restored.

Costanza's contribution to such discussions came in a series of articles over the course of three decades, all contiguous with an assortment of common and recurrent themes: 1) "getting beyond the argument culture"; 2) preanalytical visions; 3) mental models, and; 4) deliberative democracy and consensus-based decision making. Costanza adopts the concept of the "argument culture" from Deborah Tannen, a sociolinguist and author of multiple popular texts on cross-gender communication. Briefly, the argument culture, for Tannen, denotes:

> In a word, the type of opposition I am questioning is what I call 'agonism.' I use this term, which derives from the Greek word for 'contest,' *agonia,* to mean an automatic warlike stance — not the literal opposition of fighting against an attacker or the unavoidable opposition that arises organically in response to conflicting ideas or actions. An agonistic response, to me, is a kind of programmed contentiousness — a prepatterned, unthinking use of fighting to accomplish goals that do not necessarily require it (Tannen, 1998, p. 7).

Costanza's account adopts the concept of the "argument culture" and superimposes it over a vague interpretation of complexity in relation to academic disciplinarity.

> In this culture, even the most complex problems are cast as polar opposites. All discussion is cast as a debate between these two extremes in which one side is right while the other is wrong. The media, the law, politics, and especially academia are all caught in the argument culture, and its influence and control over our lives is increasing. *The problem is that, while there is nothing inherently wrong with debate and direct confrontation on some topics, it does not work for all topics*. Certainly, the complex problems that are the focus of Ecological Economics require a more multifaceted, complex approach— one that encourages real dialogue and does not cast every discussion as a zero-sum, win-lose, either-or dichotomy… The argument culture encourages defining and protecting disciplinary territories on the intellectual landscape. Sharp boundaries between disciplines, unique languages and cultures within disciplines, and lack of any overarching view makes problems which cross disciplinary boundaries very difficult, if not impossible, to deal with (Costanza, 1998, p. 113).

Costanza then extends the argument culture as an integral concept for defining ecological economics as a transdiscipline:

> One of the most frequently asked questions about ecological economics is: 'how is it different from these other disciplines?' The best answer is that it transcends the argument culture and its territorial disciplines. *It tries to create an intellectual culture where the boundaries between disciplines have been eliminated and the problems and questions are seen as a seamless whole* (Costanza, 1998, p. 114).

The italicized sections from the preceding passages provide a sort of road map for my critique of Costanza's position. In Foucault's terminology, these statements serve as "facile gestures"; contestable, normative statements that are subtly presented as descriptive ones. Paradoxically, Costanza defines the "complex" approaches needed to address "complex problems" as those characterized by "real dialogue" as opposed to "zero-sum, win-lose, either-or-dichotomy" seemingly without recognizing that his portrayal of conflict presents it's own "either-or" binary that precludes the potential necessity for, or intrinsic value of, conflict itself. Indeed, Costanza asserts that there are specific topics in which debate and confrontation are not appropriate.

By way of summary, Costanza's thesis on the subject of pluralism in EE is as follows: there are many perspectives on the nature of our reality, and those many perspectives are predicated on preanalytical assumptions -informed by subjective values - that yield preanalytical visions. Preanalytical visions, in turn, manifest as "mental models" that determine how different actors will approach different problems. Objectivity is, according to Costanza cum Schumpeter, an illusion because reality is too complex for any one model. However, in accordance with his "pragmatic" epistemological stance, Costanza asserts that models that are more capable of accurately predicting future events have greater "pragmatic utility" compared to models that are less predictive. Predictive models are, therefore, "more useful" and, therefore, impartially "better". "Bad" models (i.e., models with lesser pragmatic utility) proliferate when actors are unwilling or unable to question their mental models (informed by their preanalytical assumptions informed by their subjective values), resulting in the "argument culture". Following Costanza's interpretation of Habermas, the purpose of deliberative democracy is to overcome the argument culture by fostering consensus around a singular, holistic, boundaryless preanalytical vision that produces mental models capable of yielding the greatest pragmatic utility in the face of complex problems. Failing to do so results in information being "compartmentalized and controlled by various technical elites who do not communicate with each other. The result is that experts from various fields hold contradictory opinions and the public holds inconsistent and volatile opinions," such as climate denial (Costanza 2000).

Referring to the three provisional "archetypes" of ecological economists that I proposed in the previous section, Costanza decidedly falls within the third category; he is an ecologist whose understanding of social and cultural phenomena is in correspondence with his social ontology that derives from evolutionary and ecological theory. In other words, his preanalytical vision of social change is directly informed by systems ecology:

> Socio-ecological regimes change when "tipping points" are reached, often requiring a crisis as a trigger. However, like other evolutionary processes, cultural evolution is prone to path dependence, multiple equilibria, lock-in, and traps (Costanza, 1987; Arthur, 1988; Costanza et al., 1993). Many historical civilizations have collapsed due to their inability to escape these processes (Tainter, 1988; Costanza et al., 2007; Diamond, 2006). For example, the ancient Maya developed elaborate trade networks, elites, and cities that lost resilience to recurring drought cycles and eventually collapsed (Diamond, 2006; Heckbert et al., 2014).

These claims, interposed atop Costanza's prior position on pluralism, present several problems. First, one must ask, is Costanza suggesting that his systems ecological understanding of cultural evolution constitutes (or ought to constitute) a core concept within the "seamless" epistemological "whole" around which his ideal of boundaryless, transdisciplinary consensus must coalesce? For one thing, such an assertion raises tremendous heuristic issues concerning how exactly we should go about determining the "pragmatic utility" of cultural evolutionary theories in the first place. Moreover, and returning to the issues at the heart of this text, Costanza at no point acknowledges the innumerable intellectual traditions that reject precisely those systems theoretic conceptualizations of social and cultural evolutionary processes that Costanza endorses.

The implications of Costanza's program have proven difficult to detect due to contradictions between his prescriptions and the metaphors he uses to support them. For example, Costanza refers to the parable of the blind men and the elephant (see figure 3) as a heuristic used to communicate the concept of complexity:

> "There is probably not one right approach or paradigm, because, like the blind men and the elephant, the subject is too big and complex to touch it all with one limited set of perceptual tools" (Costanza, 1989, pg 2).

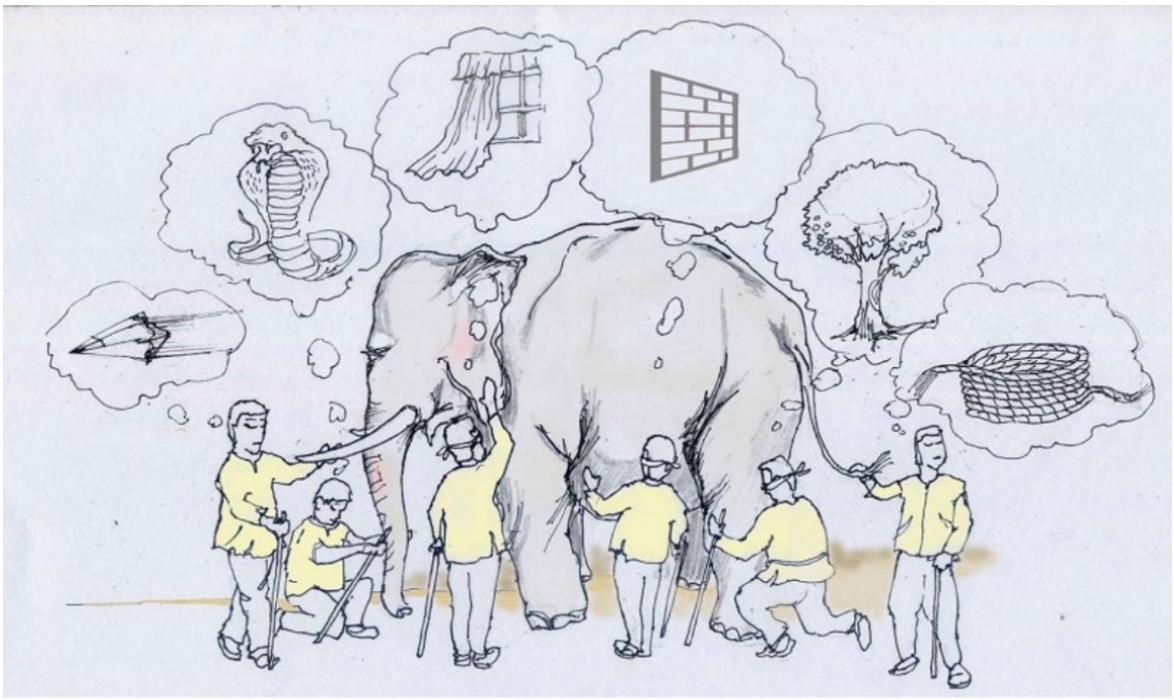

Figure 4: The ancient parable of the elephant and the blind men. Image Source: https://blog.practicalsanskrit.com/2011/02/

Why is it that a complex system cannot be understood through one limited set of perceptual tools? I will also endorse this claim, but here I wish to highlight that this claim is often made and rarely substantiated with any supporting argument, evidence, or citations pointing to the providence of the idea. As is the convention in sustainability science, Costanza asserts this claim as if it is self-evident, and in doing so projects a subtle but effective discursive practice. In reality, although it is common for authors who engage with the concept of complexity to also proffer a posture of epistemological fallibilism (e.g., Nietzschean perspectivism, American Pragmatism, or one or another expression of post-positivism, anti-positivism, anti-realism and so on), it is generally the case that the author's epistemology is only tenuously linked to the systems theory in question. Bertalanffy's epistemology, for example, cited Nietzschean "perspectivism" (Nietzsche, 1994 [1887]), but General System Theory was by no means an extension of Nietzsche's philosophical "system"[10]. By contrast, Robert Rosen was the *only* complexity theorist who explicitly defined and provided a rigorous explanation for complexity in terms

[10] Also note that Nietzsche strongly objected to systematic philosophy, and, as an extension of his perspectivism, he insisted that his philosophy should never be interpreted as systematic philosophy. However, Bertalanffy's Nietzschean "perspectivist" epistemology complements his Leibnitzian ontological perspectivism in which "each monad mirrors the totality of the universe, but only according to its own "perspective"' (see Pouvreau and Drack, 2007, p. 297-298).

of a plurality of epistemological perspectives (Lane, 2017; Mikulecky, 2007; Poli, 2010; Rosen, 1986, 2012 [1985]; Salthe, 1993; Zellmer et al., 2006).

A full account of Rosen's definition of complexity will be provided in chapter five of this text. For now, Salthe's succinct definition of Rosen's concept will provide the reader with a brief overview of the theory:

> Rosen … has proposed a metasystemic definition of complexity, to the effect that a system is complex if it can be described in many nonequivalent ways. This is [a]form of semiotic complexity, because it is (as Rosen explicitly urges) related to the observer (Salthe, 1993, p. 4)[11].

In addition to "semiotic complexity," Rosen's definition of complexity is sometimes referred to as "relational complexity," "Rosennean Complexity," or "epistemological complexity."

Critically, Rosen's definition of complexity is subjectivist to the extent that it contests even the pragmatic "weak" objectivity proffered by Costanza. To use Costanza's allegory of the blind men as an example, the "elephant" denotes the impossibility of reconciling a plurality of non-equivalent descriptive domains into a single vision that can be assessed in terms of pragmatic utility. The situation is inherently intractable, and the blind men cannot form a "shared vision" *because the blind men cannot see.* Their situated perspectives cannot be assessed or compared in terms of pragmatic utility (i.e., predictive efficacy), nor can they be combined to reach a holistic understanding through a composite image. Each man's model is inapplicable and irreducible to the others.

Furthermore, the "multiple perspectives" interpretation of complexity is neither commensurate nor compatible with the extensive interpretations of complexity proffered by several of the sources informing Costanza's ontology of social change (e.g., Tainter 1986; see Allen et al., 2017). The difference between the interpretation of complexity implicit in the allegory of the elephant and the interpretation implied by Costanza's notion of "pragmatic utility" is the difference between what Strand (2002) calls "thick" and "thin" complexity and what Cilliers (1998) refers to as the difference between "general" and "restricted" complexity. Once again, the exact nature of the incompatibilities between these concepts will be discussed at length in chapter four. For now, a useful heuristic for distinguishing between the two is that phenomena that represent "thin complexity" are, in principle, computable, whereas "thick"

[11] Salthe references Rosen's seminal 1985 text, *Anticipatory Systems,* but Rosen's definition of complexity was first proposed as early as 1969.

complexity is, I will argue, incomputable. At this point, however, I merely wish to introduce this distinction to highlight Costanza as one example of a high-profile sustainability scientist who uses contradictory interpretations of complexity interchangeably.

Furthermore, there is a conspicuous internal tension in Costanza's appeal to deliberative democracy in that he invokes systems theoretic concepts as a remedy to what Habermas called the "culture of technocratic control," seemingly unaware of Habermas's determined opposition to the application of systems theory to social theory; a trend that he perceived as a quintessential expression of technocracy itself[12] (Flood and Ulrich 1990; Ulrich and Reynolds 2010). In the broadest sense, Costanza is invoking critical theory to support a systems theoretic worldview that critical theorists historically oppose.

What should we make of those who contest Costanza's ecological social ontology within the confines of ecological economic discourse? If debate or direct confrontation is not appropriate within the topics addressed by ecological economists, then how are genuine grievances to be expressed, considered and incorporated? How do we differentiate between legitimate criticism and "the argument culture"? Where is the line, and who decides? According to Costanza, we would decide according to the "pragmatic utility" (i.e., predictive efficacy, which is measurable) of the conflicting models, but this also implies that Costanza's subjectivism is simply a form of "deferred objectivism" since there are impartial and measurable means by which to determine which model is "better." Pluralism, in his program, exists only to ultimately delimit, as opposed to proliferate, the pluralization of perspectives.

This is important because, as stated, the history of the concept of cultural evolution is inexorably entangled with eugenics, environmental determinism, and social Darwinism, and those groups and identities who have suffered the grievous consequences of those ideas are rightfully vigilant against the subtle ways in which they re-manifest in contemporary environmental discourse. That is not to say that cultural evolution necessarily, categorically, implies authoritarian imaginaries. Further, by highlighting this, it is not my intention to impugn, or cast aspersions, or speculate as to Costanza's intent. By his own

[12] The most conspicuous example is Habermas' famous rivalry with fellow German sociologist and social systems theorist, Niklas Luhmann (see Chapter 5). Although both promoted theories of social evolution, Habermas' Theory of Communicative Action is decidedly incompatible with Luhmann's theory of social systems as autopoietic unities. To be fair, I affirm that it is possible to pursue fruitful engagements between systems theory and Habermas' theory of deliberative democracy (see Farrell 2009; Ulrich and Reynolds 2010; Flood and Ulrich 1990; Flood 1990; Flood and Gregory 1989; Midgley 2000; Jackson 2003. However, doing so requires a thoroughgoing and differentiated understanding of various strands of systems theory that Costanza fails to provide. Any use of Habermas' democratic theory to support an agenda on the application of systems theory to policy science must engage with Habermas' reservations on the topic.

account, Costanza's approach to pluralism is centrally concerned with denying any affordances that might result in ecological economic discourse being used as a platform for climate denial as opposed to some covert attempt to silence marginalized groups with legitimate grievances. Moreover, what I wish to illustrate is how the former impulse– i.e., any attempt to delimit pluralism in order to exclude those who would spread misinformation - invariably has collateral consequences for the latter, particularly when contestation itself is so broadly problematized. Ultimately, although I am deeply critical of specific points made by Costanza, I affirm that his interventions hint at deeper, critical insights for sustainability science and environmental justice, but a more nuanced analysis is necessary to unlock their greater potential.

2.3.2: Multiple Antennae: Norgaard's Methodological Pluralism

Methodological pluralism was established as an epistemological norm in ecological economics - and, indeed, sustainability science more generally - since Norgaard's ground-breaking 1989 article, *the case for methodological pluralism.* Briefly, Norgaard espouses a "co-evolutionary" approach to social theory that even extends to discourse analysis. That is, Norgaard views change in social systems as a co-evolutionary process, and he views the changes in ecological economic discourse as a similarly evolutionary process. In that respect, I place Norgaard in the third category of ecological economists because his worldview is directly informed by ecological and biological theory. Critically, however, it must be said that Norgaard's application of ecological theory to social theory is decidedly anti-reductionist and anti-determinist. He is critical of both social Darwinism and progressive evolutionism more generally (see Norgaard, 1994, p. 194-196), and he is distinctly critical of all-encompassing "theories of everything" (Norgaard, 1989, p. 52-54). Insofar as Norgaard invokes a co-evolutionary approach to transdisciplinarity and pluralism in ecological economics, his argument presents a reflexive interpretation of evolution whereby fitness is mutable, negotiated by subjects, and always relative to the changing purpose of the evolutionary process in question:

> … the evolutionary course of ecological economics will depend on what "proves" fit. We have, of course, no end of economic and ecological problems on which to work. Fitness might eventually be shown through the successful application of our thinking to problems. Testing through application, however, will never be definitive because of the difficulties of controlling for many variables, because hypotheses can only be disproved (Popper, 1959),

> and because the superiority of new world views and their respective models cannot be determined (Quine, 1953; Feyerabend, 1974). Thus fitness will be determined over the coming decades by: (1) the breadth and depth of our own understanding of good method; and (2) the intellectual environment we create to sort the good from the bad (Norgaard, 1989, p. 38).

Contra Costanza, Norgaard is implying that there are no impartial means to determine whether a given predictive model has greater predictive efficacy ("pragmatic utility") because, in his words, "Ecologists understand the complexity of nature using many different frameworks, each of which helps them understand different aspects of natural systems" (Norgaard, 2010 p. 1219). In other words, according to Norgaard, all models yield only partial predictions relating to different, irreducible aspects of complex systems. Although the wording is different, Norgaard's interpretation of complexity resembles the "thick" complexity implied by the allegory of the elephant invoked by Costanza. As noted, this interpretation of complexity was first and most completely theorized by Rosen, and Norgaard, unlike many authors who invoke this concept of complexity, does provide some indication that he is aware of that connection through sources used to support his claims:

> The arguments in favor of sustaining the richness of ecological understanding parallel those for methodological pluralism in ecological economics (Norgaard, 1989; Zellmer et al., 2006; Farrell et al., 2009).

In addition to his own article, Norgaard points to Farrell and Zellmer at al., and this choice of references is very telling. Farrell, more so than Norgaard, is particularly relevant among ecological economists for her attention to both Cilliers' distinctions between "general" and "restricted" complexity as well as their parallels in Strand's distinctions between "thick" and "thin" complexity (e.g., Farrell, 2009, 2017). Furthermore, Farrell's excurses into complexity both parallel and indirectly reference Rosen through reference to Giampietro, whose interpretation of complexity derives directly from Rosen. (Note that Farrell's term "epistemological complexity" is equivalent to what Rosen calls "complexity).

Additionally, Zellmer, Allen[13], and Kesseboehmer provide a detailed and important discussion on the incompatibilities between the "conventional" definition of complexity (i.e. in which complexity is characterized by non-linearity, hierarchy of scale, uncertainty, self-organization, and emergence) employed by complex adaptive systems researchers (e.g., Berkes et al., 2002) and the epistemological-semiotic-relational definition proposed by Rosen. Following Rosen, Zellmer et al. note:

> Any unified account is lacking, because it fails to capture the contradictions and complementarity. It is no accident that the literature of complexity has definitions of complexity that are at odds with each other. This lack of agreement as to the one definition of complexity has its roots in the infinities of Rosen's complexity forced into a smaller space by the modeling exercise. As the dynamics and semiotic linguistics clash, contradiction emerges (Zellmer et al., 2006, p. 177).

Norgaard (2009) indirectly invokes Rosen's interpretation of complexity (through reference to Zellmer et al., but also through his own description of complexity) in the context of his critique of payments for ecosystem services. He contends that the concept of ecosystem services is predicated on the "stock-flow" model of ecological function, and he affirms that ecologists attend to the complexity of ecosystems through a far more expansive plurality of approaches. Thus, for Norgaard, the idea of payments for ecosystems services acts as a "complexity blinder" in that it precludes the myriad other valid methodological approaches for understanding ecosystems. At face value, this critique appears paradoxical; on the one hand, Norgaard invokes complexity to argue for methodological pluralism, while on the other hand, he invokes complexity to criticize one method in particular (i.e., PES). Norgaard's critique, however, is entirely consistent with his pluralist interpretation of complexity in that he stops short of calling for the outright exclusion of ecosystem services from EE discourse. Rather, he warns against the dangers associated with overreliance on any one approach to ecological modelling. In short, Norgaard's pluralism opposes any one model that threatens to exclude all others.

[13] Allen is another notable theoretical ecologist whose concept of complexity derives directly from Rosen's theory of the modelling relation. Giampietro, a close colleague and former post-doctoral supervisee to Allen, also adopts Rosennean complexity as do his numerous students along with his long-time collaborator, Kozo Mayumi. I refer to this lineage as the "MuSIASEM genealogy" after Giampietro and Mayumi's methodology for resource accounting and sustainability assessment: multi-scale integrated analysis of societal and ecological metabolism (MuSIASEM, see Giampietro et al., 2012). In general, any references to complexity made within this genealogy are either explicit or implicit references to Rosen.

Shortly after Spash (2012, 2013) re-ignited the pluralism debate in ecological economics by calling for the wholesale exclusion of orthodox economic theory (i.e., PES and environmental economics), Goddard, Norgaard, and Kallis reassert the following:

> Foreseeing and responding to change in complex systems requires keeping multiple methodological antennae up. Understanding or predicting how coevolving systems change requires more than linear or mechanistic thinking allows. *Understanding complex adaptive systems– by embracing uncertainty, non-linearity, and surprise – along with learning and experimentation, are desirable features for resilience, defined as the capacity to withstand change, adapt, and transform toward sustainability* … Evidence also supports diversity, reflexivity, and flexibility as key elements of managing and responding to complexity both in high pressure-environments … and on the path toward sustainable transitions (Goddard et al., 2019 p. 165, emphasis mine).

Here, Goddard et al. invoke an interpretation of complexity termed "conventionalized complexity' by Zellmer et al. Conventionalized complexity is the view that systems are complex when they exhibit a set of characteristics that are supposedly common to complex systems; i.e., non-linearity, uncertainty, hierarchy of scale, emergence, self-organization, and resilience. Once again, the "conventional" interpretation of complexity employed in complex adaptive systems research is not commensurate with relational complexity. However, like Costanza, and contrary to Zellmer et al., Goddard et al. invoke Rosennean (i.e., thick) complexity and conventional (i.e., thin) complexity interchangeably, and, once again, there are a host of problems with doing so. As stated, the nuances of the incompatibility between these interpretations of complexity will be discussed more fully in chapter five, but in their simplest terms, the dichotomy can be understood as follows: the theory and methodology of complex adaptive systems, not unlike the stock-flow model for ecosystems, represents *one perspective* for understanding complex systems. Following Zellmer et al. by defining a conventional list of characteristics by which complex systems can be identified and by devising a suite of methodologies for "managing and responding to complexity" according to those characteristics, the approach of complex adaptive systems attempts to *simplify* complexity. In other words, complex adaptive systems are not complex by the standards of Rosen and Zellmer et al., they are merely "complicated" (or "thin" complexity using Strand's terminology). Most importantly, complex adaptive systems, as will be discussed in chapter five, directly derives from computational theory and von Neumann's cellular automata in particular. For this reason, many social theorists, including critical systems theorists, view the application of complex

adaptive systems to ecosystems ecology as a distinctly mechanistic and positivistic affair. Most notably, Resilience thinking, which draws many theoretical features from complex adaptive systems research, is extensively problematized by political ecologists due in no small measure to the enthusiasm with which proponents of neoliberalism have embraced resilience concepts (see chapter 3 of this text). For political ecologists, both complex adaptive systems and resilience thinking constitute forms of functionalism, determinism, and, therefore, anti-pluralism. Norgaard, however, does not address these tensions when he endorses complex adaptive systems theory.

Taken as a whole, Norgaard's account is an important example in which the conflation of complexity concepts propagates contradiction and confusion. Norgaard sets his ecological view against the constellation of positivism, mechanism, and economism. That is, for Norgaard, complexity is an epistemological position in its own right, one that he views as characteristic of an essentially ecological worldview that serves as a sort of spiritual remedy to the mechanistic worldview of economics. Once again, there are multiform problems associated with valorizing ecology. As Norgaard himself admits, economics and ecology also "co-evolved" as distinct but related discourses. Norgaard himself alludes to the multiple entanglements between the two:

> …economics and ecology share the same Greek root, oikos. Furthermore, economists and ecologists both explore complex systems in a manner sufficiently similar that there have been important conceptual transfers. Darwin and Wallace credit Malthus with alerting them to the dynamics of a population meeting a resource constraint. The mathematical models of population biology and the patterns of explanation used to account for foraging and reproductive strategies are the same as those of economics… Some economists apply their knowledge to ecosystem protection and some ecologists apply their knowledge to economic development. *Nevertheless, the two disciplines are the scientific components of divergent world views* (Norgaard, 1989, p. 39).

The prevailing problem with Norgaard's account is its inability to draw a coherent line between these two supposedly opposite worldviews, and, as Spash (2012) also notes, this incoherence stems from confusion as to the nature and role of positivist philosophy in the science of ecology. Norgaard, one will recall, associates ecology with an anti-logical-positivist worldview, and this claim is inaccurate for a number of reasons. First, Norgaard associates economic ideology with the philosophy of *logical* positivism, claiming that "Logical positivism has been the dominant methodology of science for several centuries" and that neoclassical economics, in turn, conforms to the epistemological assumptions of

logical positivism. As a matter of history, this claim is simply false. Logical positivism emerged in the 1920s, developed by the members of the Vienna Circle, such as Gottlob Frege and Rudolf Carnap. The explicit purpose of logical positivism was the application of Wittgenstein's logic to displace the metaphysics of German Idealism. Very briefly, the enterprise of logical positivism disintegrated due to Gödel's incompleteness theorem. Shortly thereafter, logical positivism gave way to the Logical Empiricism of Neurath and later to the 1950's post-positivism of Karl Popper, Thomas Kuhn, Michael Polanyi, Willard von Orman Quine, and Feyerabend. After a near century of relentless assault, there are comparatively few scholars who still today identify as *logical* positivists. Norgaard is also mistaken for associating neoclassical economic theory with logical positivism despite the former having emerged a half-century prior to the latter. Neoclassicists were indeed influenced by Comptean positivism after the late 19th-century French philosopher Auguste Compte, but the broader point here is that Logical positivism and Comptean positivism, although related, are not equivalent. The epistemological positions of mainstream economists tend toward various expressions of the same post-positivism that are endorsed by many contemporary ecologists and, indeed, by Norgaard himself. In other words, Norgaard's critique of the epistemologically reductive assumptions implied by logical positivism is not necessarily germane to the epistemological assumptions of contemporary post-positivist economic theory. Ultimately, the entire argument is moot because Norgaard concedes that positivism is a necessary evil.

There is a subtle tension in Norgaard's position in that the very ecosystems ecology that he endorses was originally a distinctly positivist and anti-idealist project. In this manner, Norgaard does not only tolerate the positivism at the root of neoclassicism and neoliberal but also actively, albeit perhaps unconsciously, endorses expressions of it. In doing so, he further complicates the already fuzzy distinction he draws between economic and ecological worldviews. Following Anker, (2002) and (Hagen 1992), Tansley, the progenitor of ecosystems ecology, introduced the very concept of the eco-system as a direct counter to vitalist-idealist-organicist interpretations of vegetative communities that dominated primarily American naturalism in the early 20th century; notably, the work of Frederick Clements and Robert Collingwood. Tansley's positivist-mechanist approach[14] to ecology was also ideologically meant to counter the affinity between idealist ecology and socialism (whereas Tansley, after his liberal mentor,

[14] From Worster (1994, p. 175): "[Tanley's] source of inspiration was not biology but physics. Nature is organized into inflows and outflows of energy, and the whole is an amalgamation of both living and nonliving components…. [His] notion of the ecosystem was founded on the assumption that the entire universe is firmly structured into complex physical interactions and that science can make sense of that structuring only by selecting small ordered pieces of it to study and describe"

Herbert Spencer, strongly rejected communitarianism). Thus, the affinity between positivist ecosystems ecology and positivist economic science in the early 20th century was partially by design. Contemporary economics was thoroughly influenced by many of the same systems theories that Norgaard champions (Mirowski 2002). As noted, complex adaptive systems research (which informs Holling's resilience thinking) extends Von Neumann's cellular automata, which, in turn, provides a key theoretical touchstone for neoliberal economic theory after Hayek (Mirowski 1988, 2002, 2021; Mirowski and Plehwe 2009). Additionally, Hayek was profoundly influenced by the cybernetic systems ecology of Hardin (Oliva 2016). As Mirowski has demonstrated repeatedly, ecology and economics mirror one another's movements; they are often two branches of the same tree. This account will be further explored in chapter 4 of this text, but for now, I rest my critique with the assertion that ecology and economics are not the contradictory worldviews that Norgaard describes them as.

In summary, there is much to admire in Norgaard's ecological and co-evolutionary approach to pluralism and transdisciplinary, but the tensions left unchecked since the original 1989 article are becoming more apparent over time. Methodological pluralism is both descriptively and normatively problematic. It misconstrues the epistemological assumptions of contemporary economic theory; it conflates mechanistic and anti-mechanistic concepts of complexity, and it inappropriately makes affordances for the former in the name of the latter; it fails to meaningfully distinguish between ecological and economic worldviews, and it provides few prescriptions on how to resist the hegemony of the latter.

2.3.3: Biophysical Reductionism and the "Roots" of Ecological Economics

The third perspective I wish to critique is that provided by Melgar-Melgar[15] and Hall in a recent special issue of the Journal of Ecological Economics on future directions for ecological economic research. Their article entitled, *Why ecological economics needs to return to its roots: The biophysical foundation of socio-economic systems,* criticizes Norgaard's methodological pluralism for having "opened the doors for the very theories and methods that were once the focus of its critique" with the result that "EE has since become better known for efforts to "green" the exchange economy through the monetary valuation of nature". Thus, following Spash (2013) and Anderson and M'Gonigle (2012), Melgar-Melgar and Hall

[15] Hall is a highly influential and established systems ecologists and ecological economist, and this piece summarizes and extends arguments made in a collection of his texts over multiple decades. Melgar-Melgar, by contrast, is currently a PhD candidate and is a colleague of the author of this text through the Economics for the Anthropocene/ Leadership for the Ecozoic project community. Furthermore, Melgar-Melgar participated in a series of workshops organized by Kish and Mallery yielding a publication (Kish et al. 2021) that engages multiple critiques contained herein.

critique transdisciplinary pluralism on the grounds that it paradoxically enables orthodox hegemony in the form of payments for ecosystem services[16]. This claim – i.e., that research on payments for ecosystem services is steadily displacing the more conventional subjects of ecological economic discourse - is indeed supported by Plumecocq's (2014) lexicographic analysis of the Journal of Ecological Economics. In terms of the sheer quantity of publications by subject, it would appear that ecological economic discourse is converging with that of environmental economics (i.e., an orthodox field of economics that applies mainstream economic methods and theory toward addressing environmental problems). To address this trend, Melgar-Melgar and Hall call for a form of graduated pluralism in which EE discourse is bounded by the insights of "biophysical economics" (BPE), which, they argue, constitutes the fundamental "roots" of the ecological economic discourse.

To situate their claims, Melgar-Melgar and Hall provide a cursory history of the biophysical perspective in economic and ecological thought, respectively. As noted earlier in this chapter, their account, like all historical accounts, contains numerous normative assumptions that effectively situate the authors within a North American genealogy in EE research that is predominantly concerned with energy accounting in the tradition of the systems ecologist, Howard T. Odum[17].

I will not yet critique Melgar-Melgar and Hall's account of the history of EE other than to note that it; a) overstates Howard T. Odum as a central figure in EE discourse and; b) it fails to mention the significant differences between the various proto-ecological economists that provided the intellectual and historical context for contemporary EE discourse (namely Kenneth Boulding, and Nicholas Georgescue-Roegen) and instead subsumes all of these disparate theories within the umbrella of "biophysical economics". These critiques will be pursued in chapter five. For now, I will limit my critique to MM and Hall's core assertions relating to the previously stated themes of this chapter (i.e., complexity and pluralism).

Pursuant to their account of the history of ecological economics, the "thrust" of Melgar-Melgar and Hall's argument is contained in the following passage:

> Real economies must be studied as both biophysical and social entities. Biophysical principles that take into consideration complexity and apply a systems thinking approach

[17] Hall, like Costanza, was a prominent student of Odum. Unlike Costanza, however, Hall's research keeps much closer, both philosophically and methodologically, to Odum's. Indeed, Melgar-Melgar and Hall's article serves as a direct rebuke of both Costanza and the ecosystems services approaches he champions.

> are necessary for future re- searchers in ecological economics and other allied fields to understand why and how we can bring our socio-economic system in line with the many constraints of the biophysical world. Odum (1971) stated that *"when systems are considered in energy terms, some of the bewildering complexity of our world disappears; situations of many types and sizes turn out to be special cases of relatively few basic types."*[18]
>
> While forcing social sciences into rigorous and possibly incorrect mathematical frameworks might be inappropriate, *even more in- appropriate is the failure to recognize that the social system must have biophysical foundations, and biophysical systems must obey physical laws and immutable rules*. Neoclassical economics provides an excellent example because it often tries to apply more mathematical rules under the illusion of being scientific, but ends up with a model and production functions that largely ignore fundamental physical [or scientific] laws, e.g., energy, raw material, and waste (Georgescu-Roegen, 1971; Daly, 1977; Mirowski, 1989; Hall et al., 2001). This has led economists and policy advisors to project indefinite economic growth and to *believe that the price mechanism is the only feedback loop required to drive the complex ecological-economic system to equilibrium.* Therefore, if EE takes its biophysical foundation seriously this would rule out certain assumptions and methods of neoclassical economics. (Melgar-Melgar & Hall, 2020, p. 4, emphasis mine).

Taken in isolation, this statement is innocuous, if not conciliatory, toward social theorists. It does, however, raise a series of questions relating to pluralism and complexity. First, how, according to Melgar-Melgar and Hall, should researchers study social entities, and how ought the study of social entities differ (if at all) from the study of biophysical entities? The answer to both, according to Melgar-Melgar and Hall, seems to be: according to a "complexity and systems thinking approach". This raises the second question: what constitutes a "systems thinking approach"? In short order, Melgar-Melgar and Hall provide the same answer for both questions: Odum's systems ecological theory, expressed in his formal energy systems language.

Briefly, Odum's formal energy systems language is a quantitative modelling approach inspired by similar models developed in early ecosystems ecology by Odum's mentor and Ph.D. supervisor, G.E. Hutchinson. Both Hutchinson and Odum, in turn, were inspired by the servomechanical models of first

[18] This statement is nearly identical to the dictionary definition of reductionism. By affirming this statement, Melgar-Melgar and Hall are affirming reductionism.

order-cybernetics[19]. The purpose was initially to diagrammatically represent resources and, primarily, energy flows through ecosystems to determine pathways of optimal energy usage, thereby transforming ecology from a descriptive to a (allegedly) predictive scientific enterprise.

> The maximum power principle states that during self-organization, system designs develop and prevail that maximize power intake, energy transformation, and those uses that reinforce production and optimum efficiency (Odum, 1971, 1994).

For Melgar-Melgar and Hall, the only valid future for ecological economic discourse is predicated on the categorical acceptance of the principle of maximum empower as an immutable scientific fact. In light of this assertion, their previously conciliatory statements adopt a problematic new valence. This is important because if maximum empower is the lens through which society ought to be understood, then optimum energy efficiency logically becomes the core imperative of social organization. However, to paraphrase the welfare economist, Amartya Sen, a society can be optimally energy efficient and still perfectly disgusting[20]. In part, this is why I have chosen the moniker biophysical economism, to describe the view from Melgar-Melgar and Hall; it is the view that all social ills derive from inefficiencies within an otherwise perfect, self-organizing process that would solve all social ills if external forces stopped interfering with the otherwise transcendental logic of the evolutionary process. In essence, Melgar-Melgar and Hall object to the idea to the idea that "the price mechanism is the only feedback loop required to drive the complex ecological-economic system to equilibrium" on the basis that the "true" self-organizing process that attenuates all other social realities is energetic as opposed to the profanely immaterial and abstract logic of the market. The same fallacy infects both positions, the idea that there is a core principle that underwrites an all-encompassing naturalism that renders all non-naturalistic theory moot. For Odum, maximum empower both explained history, politics, culture, and even religion, as well as served as a normative imputation for all human pursuits. In Odum's own words:

> I think what the world needs to do, is to realize that there are these common principles of energy, materials and information that apply to everything. Humans, in the midst of it, *think that they are making choices, and they are, but they are choosing between actions that fit*

[19] Hutchinson was a significant figure in the post-war Macy conferences that famously extended the methods and theories of first-order cybernetics and operations research to new frontiers in the social and natural sciences (see Hammond 2003).

[20] From the original quote "a society can be Pareto optimal and still perfectly disgusting."

> *the principles and thus will prevail, and actions that don't fit and fail*. This concept is hard to get across, even to those in the ecological societies (Odum, 2001, p. 11)[21].

However, one must ask, if maximum empower should be used to determine the course of politics, culture, history, and religion, then what else can it be used to justify? Where does it end? Most strikingly, what does the word "prevail" mean in this context, and what does "prevailing" engender in terms of how people, cultures, or perhaps civilizations interact? Does it look like genocide? Subjugation? Assimilation? Melgar-Melgar and Hall cursorily dismiss these concerns.

> A particularly challenging and *not always comfortable* issue is the degree to which history can be understood from the perspective of maximum power. Do countries that do not use oil as rapidly as possible just "take themselves out of the race" and leave that for others to exploit? (Melgar-Melgar & Hall, 2020; note that this passage faithfully re-uses language from the abstract of Hall, 2004).

The authors leave these questions open and, thereby, conspicuously ignore the fact that Odum's answers would have been an unequivocal affirmative to all of the above. Despite the authors' euphemistic acknowledgement that this issue is "not always comfortable," there is no way to avoid the inherently social Darwinist logic of maximum power. Indeed, profoundly dangerous ideas are never "comfortable" for those they endanger, and Chapter Five of this text demonstrates that the genealogy of maximum empower traces directly through Alfred Lotka and Arthur Tansley[22] to Herbert Spencer - the true progenitor of social Darwinism - and his energetic theory of universal evolution (see Hofstadter, 1944; Peet, 1985; Ruse, 1980). Furthermore, the neoclassicist subversion of Von Helmholtz's energetics was underwritten by Spencer's having already interpreted Helmholtz in such a way that allowed for the uniform application of energetics to social theory, psychology and biology collectively from his First

[21] The quote from Odum continues: "We even have a controversy with a former student about whether *deterministic principles* that apply both above and below the human scale apply to ecological economics, which is a field which we started, relating people, environment, and money" (p. 11, emphasis mine). This passage reveals two things: first, that Odum was aware and embraced the fact that Maximum Empower constituted a form of environmental determinism. The concept of "choosing between actions that fit the principles" is analogous to Hobbesian determinism, also known as "compatibilism." Second, the "student" with whom Odum had controversy was Robert Costanza, and later in the interview text (p.38), Odum notes that Costanza, as editor in chief of the Journal of Ecological Economics, marginalized Odum's influence in EE by removing him from the editorial board and placing a moratorium on any papers involving Odum's concept of *emergy* (i.e., energy memory) and maximum empower.

[22] Note that Tansley served as Spencer's assistant for a decade, and he is credited with having provided substantial editorial input on the second editions of Spencer's *Principles of Biology* (Spencer, 1873 [1898]).

Principles (Mirowski 1989)[23]. Contrary to biophysical economists' claims that they represent an opposing and contrary perspective to neoclassicism, it is important to understand that their predecessors, Lotka and the neoclassicists, did not oppose one another; they were all deeply inspired by Spencer's functionalism, and all were equally committed to the quantification and formalization Spencer's evolutionism in diverse and complementary ways. Contemporary biophysical economics predicated on the principle of maximum empower is a different expression of the same equilibristic, social-Darwinist functionalism that governs neoclassicism; they are parallel forms of progressive evolutionism and economism[24].

Accordingly, Melgar-Melgar and Hall are implying that functionalism is the only legitimate means for studying" social entities".

> Ecological economics should not be restricted and cannot be reduced to biophysical analysis, but its theories and methods must be consistent with biophysical principles. As such we believe that economics needs to be based as much on the biophysical (i.e. natural)

[23] Following Mirowski: "Because his First Principles is not often read today, it has not been appreciated that it was one of primary vehicles for the promulgation of energetics in the later nineteenth century (Capek 1961, p. 100-3)… Employing the already anachronistic terminology of the "Persistence of Force," Spencer discussed the conservation of energy as if it were not only a confirmed physical theory, but also an epistemological necessity verging on a priori truth. In retrospect, this seems extremely bold, given the relative novelty of the doctrine at that time. Not being one to stop there, Spencer then asserted that "the law of metamorphosis, which holds among the physical forces, holds equally between them and the mental forces" (Spencer 1887, p. 217). According to Spencer, there was only one generic energy, and its laws should apply equally to physical and social phenomena" (Mirowski 1989, p. 266). By extension, Spencer's subsequent, and thoroughly impactful, texts, including *The Principles of Biology* (1864, 1867, 1898)*, The Principles of Psychology* (1880,1890)*, The Principles of Sociology* (1875, 1885)*, and the Principles of Ethics* (1879, 1891) were all similarly predicated on the nascent natural philosophy of energetics. Despite their apparent differences, the disparate strands of Spencer's thought each traced back to the same source, and effectively manifested "different aspects of the same protyle", attempting to parallel developments in physical science. For Spencer, the "Principle of Persistence of Force" constituted the "truest expression of ultimate reality" (Capek 1961, p. 102).

[24] See Worster 1994: "Unrelated as it may have seemed at first, energy turned out to be the key that opened the gate to the economic approach… Without economics, ecologists might have disappeared as an independent class of researchers; as it is, ecology occupies a clear, safe, and highly prominent place squarely between the two most influential academic disciplines of our time" (p. 311-312). Also see Mirowski's 2021[1996] response to Worster, *Ecology in the Mirror of Economics:* "Energy was not simply "the key that opened the gate to the economic approach" (Worster, 1994, p.311); it just paved over a footpath with a four-lane highway. I think it particularly important to heed recent historians who insist that changing notions of natural selection track simultaneous changes in notions of physical dynamics (Depew & Weber, 1995); economists have similarly glanced enviously at changing conceptions of dynamics, and have been notorious in their attempts to co-opt various notions of selection and evolution for their own purposes over the course of the century" (p.3).

> sciences as the social sciences, and it must fully understand and acknowledge the constraints the biophysical world puts on economics (Melgar-Melgar & Hall, 2020, p. 11).

As conciliatory as this statement appears, this sort of rhetoric rings hollow in the absence of any attempt by the authors to re-fashion their explanatory frameworks to provide some, if any, allowances for anti-deterministic social theory. They do not grasp how totalizing theories such as maximum empower *supercede* alternatives and are, therefore, inherently incompatible with non-functionalist social theory. Indeed, this was Odum's intent because he, unlike Boulding and Georgescu-Roegen, viewed biophysical *constraints* as social and economic *determinants*. He viewed social and economic phenomena as epiphenomena of deterministic biophysical phenomena, and it was his belief that economic analysis *must* be reduced to biophysical analysis for economics to be "consistent with" the nomothetic biophysical principles that govern everything.

Collectively, these issues illustrate the perennial problem of agency-structure dualism that has haunted the philosophy of sociology since its inception. Here, Melgar-Melgar and Hall are promoting Odum's wholly structural determinist theory that, by necessity, invalidates the agency and free will of individuals and groups. If, for example, as the authors suggest, ecological economists should embrace maximum empower as an "immutable biophysical principle"[25], then they are compelled to also accept the imputations and implications of that concept, because maximum empower is an all-encompassing theory of everything that necessarily precludes and invalidates all other coextensive ontologies. Principally, maximum empower naturalizes social and political discourse by asserting energy efficiency as a central, overriding selective mechanism that governs the inexorably progressive evolution of social and natural systems. Most importantly, once again, maximum empower also naturalizes history. From this view, genocide, warfare, and colonialism are simply inevitable consequences of more efficient social systems "prevailing" over their "less fit" counterparts who opted to "take themselves out of the race."

[25], In his rebuke of Sagoff's claim that theoretical ecology seeks to posit positivistic, general laws of ecology, Donhauser (2016) points out many scientists do not consider scientific laws or principles to be inexorable or immutable. By arguing the contrary, Melgar-Melgar and Hall not only betray their realist posture, but they also undermine the efforts of theoretical ecologists in resisting the perception that the theory of ecology is not commensurate with its methodological and predictive potential (see also various contributions from Pimentel et al., 2000). Following Donhauser, comparatively few theoretical ecologists conform to the "superannuated positivism" Sagoff both accuses them of and demands that their theories should live up to. In other words, Melgar-Melgar and Hall represent a tangible example of what is otherwise a caricature that Sagoff extends the whole of theoretical ecology.

Quite obviously, the theoretical posture endorsed by Melgar-Melgar and Hall represents social Darwinism (sic "Spencerism"), structural functionalism, and environmental determinism.

Taylor (1988), Odum's most ardent critic, uses the term "technocratic optimism"[26] to describe the normative, political imputations associated with maximum empower – the notion that decisions pertaining to policy, governance and even culture could and should be made objectively according to the path that maximizes energy efficiency[27]. For Taylor, maximum empower represents a pernicious form of systems-theory-as-liberal-policy-science that renders the "systems thinker" in a dominant position akin to the philosopher kings of Plato, in which expert knowledge of systems, their properties and behaviours, places the systems thinker in a meta-theoretical position above and beyond other theoretical positions. And, indeed, there is an implicitly Platonic rhetorical subtext to Melgar-Melgar and Hall's argument. Any plurality of perspectives is regarded as a problem rather than something of intrinsic value. Complexity, they intone, is a consequence of someone being wrong; a problem that "disappears' when the correct (i.e., most fundamental, i.e., energetic) perspective is arrived at. Other perspectives are complementary at best but ultimately secondary.

Like Costanza, Melgar-Melgar and Hall endorse a "thin" interpretation of complexity – the idea that complex problems can be "solved" - that corresponds to a thin interpretation of pluralism. One is left to wonder who within the EE discourse this comment is directed at or what threat exactly the authors felt this intervention was necessary to counteract. What Ropke calls the "banal" insight of ecological economics is indisputable even among orthodox economists (see Daly, 1997; Solow, 1997; Stiglitz, 1997). But the subtle sleight of hand, the "facile gesture," occurs when Melgar-Melgar and Hall seamlessly transition from the "banal" argument of ecological economics to a far more esoteric argument in favour of Odum's Principle of Maximum Empower, and this may hint at their broader intent. It is quite one thing to claim that orthodox economics is flawed for its ignorance of the second law of thermodynamics, but it is another thing entirely to suggest, as they do, that there is a fourth law of thermodynamics underlying an inexorable process of energetic social historicism. The key problem with Melgar-Melgar and Hall's argument lies in the false equivalence between maximum empower and the second law, as if denying one general "law" implies that the other object possesses equivalent significance. In truth, almost nobody denies the second law, but the majority of social theorists over the

[26] Alluding to the ways in which Odum's formal energy systems language far exceeds the intended reach of the very cyberneticians, such as Wiener, from whom Odum draws theoretical and methodological inspiration.

[27] Odum endorsed Marxism because it was, in his analysis, the most energy efficient form of governance.

last century oppose the confluence of biophysical and social determinism represented in Odum's theory of maximum empower. Indeed, many natural scientists and philosophical realists are equally if not more vociferously, opposed to biophysical economics than are their constructivist counterparts (Peters 1991; Sagoff 2003, 2015, 2016). For Sagoff, the principle of maximum empower is both an expression of Whitehead's Fallacy of Misplaced Concreteness[28] (Sagoff 2013; Whitehead 1925) as well as a form of "closet creationism"; the sublimation of the neo-Aristotelian "Great Chain of Being" theology into modern evolutionary social theory[29].

Ultimately, Melgar-Melgar and Hall insist that their perspective should constitute a privileged perspective within a stratified caricature of transdisciplinary pluralism. Effectively, this proposal would cut ecological economics off from potential allies among qualitative environmental social theorists who criticize systems ecologists' desire for "pre-eminence" over other fields as evocative of a more fundamentally rooted, technocratic and hierarchical worldview. Following Bookchin:

> What ultimately distinguishes an ecological outlook as uniquely liberatory is the challenge it raises to conventional notions of hierarchy. Let me emphasize, however, that this challenge is implicit: it must be pains? takingly elicited from the discipline of ecology, which is permeated by conventional scientistic biases. Ecologists are rarely aware that their science provides strong philosophical underpinnings for a non-hierarchical view of reality. Like many natural scientists, they resist philosophical generalizations as alien to their research and conclusions - a prejudice that is itself a philosophy rooted in the Anglo-American empirical tradition. Moreover, they follow their colleagues in other disciplines and model their notions of science on physics. This prejudice, which goes back to Galileo's day, has led to a widespread acceptance of systems theory in ecological circles. While systems theory has its place in the repertoire of science, it can easily become an all-encompassing,

[28] From Whitehead (1926, p. 52): "the error of mistaking the abstract for the concrete." Sagoff is undoubtedly well aware that ecological economists after Daly (e.g., Daly & Cobb, 1994) also commonly invoke the fallacy of misplaced concreteness in their critique of neoclassical economics.

[29] I will revisit and critique Sagoff's claims in a later section. In short, he asserts that systems ecology (and EE by extension) derives from Herbert Spencer, and Spencer was a closet creationist. The first claim, as I have noted, is salient: *both* neoclassical economics and Odum's systems ecology are genealogically tied to Spencer. They are, in many respects, divergent expressions of the same functionalist reductionism. Sagoff's claim, however, that Spencer was a "closet creationist" is extemporaneous at best, and risks feeding into the common misconception that Spencer's Social Darwinism was somehow divergent from the "true" enlightenment values of positivism, empiricism and materialism when, in reality, he was a consummate enlightenment liberal scientist on all counts (Haines 2017). Attempts to re-cast Spencer as an idealist, vitalist, or neo-Aristotilean are covert attempts at exonerating secular humanism for having produced and perpetuated modern racist ideology (see also West, 2002).

> quantitative, reductionist theory of energetics if it acquires pre-eminence over qualitative descriptions of ecosystems, that is, descriptions rooted in 'organic evolution, variety, and holism. Whatever the merits of systems theory as an account of energy flow through an ecosystem, the primacy it gives to this quantitative aspect of ecosystem analysis fails to recognize life-forms as more than consumers and producers of calories (Bookchin, 1983, p. 26-27).

To clarify my own position: I embrace biophysical analysis and I concur with the opinion that it is indispensable to ecological economics and sustainability science more generally. However, it is *because* I endorse biophysical approaches that I oppose the idea that it should supersede or displace idiographic forms of analysis because such a dominant posture only serves to isolate and marginalize theoretical ecology at best and, at worst, it provides conceptual cover for authoritarian political impulses (see chapter 3). I maintain that the ontological reductionism of biophysical economism is separable from the *methodological* contributions of Hall and his students. For example, Hall's concept of energy return on energy investment provides an accessible and analytically fruitful means for organizing our understanding of the biophysical constraints that socio-economic systems are subject to. Furthermore, I contend that there is nothing, in principle, problematic about suggesting that social-economic systems that are subject to excessive energy and resource constraints are also subject to associated challenges and might even exhibit certain behavioral propensities[30]. Indeed, it is difficult to imagine how the issue of diminishing outputs associated with any input in nearly any process could *not* engender a substantial effect on the outcome of the process itself. Efficiency is an advantage in many forms of competition, be it evolutionary, economic, or, say, geopolitical, but it must be assessed against any number of coextensive, contextual factors acting on the unit of social analysis in question. The reductionism of energy efficiency has no greater merit than market efficiency; both are forms of economism.

[30] One example is Tainter and Allen's theory of Energy Gain, which bears many similarities to maximum empower. Hornborg, who is critical of Odum's energetics in ecological economics, similarly dismisses energy gain as reductionism. And yet, there are subtle rhetorical differences that distinguish Tainter and Allen from Odum and Hall. First, energy gain is presented with a constructivist epistemology. Tainter and Allen are suggesting that systems with higher energy gain have a competitive advantage, but they are not suggesting that this advantage constitutes an immutable principle in nature. Second, Tainter and Allen provide Xin Dynasty China as an historical counterexample (albeit the only one) in which a society chooses to "de-complexify" by adopting a less energy efficient pathway. Nonetheless, this theory is highly contestable, and I do not suggest that it is an unproblematic alternative to maximum empower. Rather, I am highlighting how Tainter and Allen's argument provides caveats that allow it to exist within pluralistic discourses. Robert Ulanowicz, James Kay, Stuart Kauffmann and Stanley Salthe are further examples of theoretical ecologists who engage similar themes with an explicit awareness of the dangers of social and environmental determinism.

Ultimately, ignoring structure in social theory presents as many problems as ignoring agency, and these tensions account for the rise of complementary perspectives - such as, for example, "structurational" theories (i.e., theories of complementarity between agency and structure) in sociological thought - to address the deficits of the relative "imperialism" of social objects and subjects against one another (Giddens 1984, 1997). Such claims, however, require substantial caveats and considerations, clearly telegraphed and possessing care and mindfulness as to the history of conflict associated with the concepts in question. If Melgar-Melgar and Hall interpret social energetics in pluralistic or complementarist terms, then it is necessary for them to first situate social energetics within ontologies that make affordances for agency, and they do not. At the very least, the authors might respond to notable critics of their approach, such as Boulding, Taylor, or Mirowski. As it stands, however, the authors ignore Taylor and, in travesty, present Georgescu-Roegen, Boulding and Mirowski *in support* of a position that they strongly oppose(d). Without these interventions, the re-centring of biophysical economism (i.e., "going back to the roots") in EE discourse would represent a retrograde motion without any tangible benefit.

2.3.4: Critical Realism for a Smaller Big Tent

Spash is credited with having inaugurated the recent ecosystem services debate in ecological economic discourse with a series of controversial publications over the previous decade (Spash 2008, 2011, 2012, 2013, 2017, 2019). As such, each of the four concurrent perspectives explored in this chapter, to some extent, all respond to the critiques discussed in this section. Costanza, for example, rejects Spash's argument wholesale, whereas Hall accepts his critiques whilst promoting different – more epistemologically realist – prescriptions. Norgaard, whom Spash both criticizes and embraces at various points, is commensurably more circumspect.

Spash's agenda to reshape EE discourse constitutes a significant project, and, as such, the full nuance of his many arguments to that effect will be impossible to encapsulate here. Regardless, by way of summary and some simplification, I maintain that the thrust of Spash's argument is that ecological economics has faltered by permitting environmental economics (i.e., orthodox economic theory) vis-à-vis research on payments for ecosystems to dominate the contemporary EE discourse. Following (and paraphrasing) Naess (1973), Spash contends that a "shallow, but presently rather powerful movement, and a deep, but less influential movement, compete for our attention" (Spash, 2013, p. 351). To distinguish between the two spheres of EE discourse, Spash proposes a (controversial) typology of ecological economists according to his interpretations of their "ideological and theoretical positions" in

the interests of "pointing out where substantive divisions, and inconsistencies, lie" (p. 352). In some respects, Spash's attempts at categorization resemble what I am attempting to do in this text, although I will forewarn the reader that his distinctions between "shallow" and "deep" ecological economics should not be taken to conform to my own distinctions – following Strand and Cilliers – between approaches grounded in either thick or thin complexity. Additionally, although I embrace many aspects of Spash's critique of particular strands of ecological economic discourse, I am also highly critical of certain aspects his proposed prescriptions to address them (namely, standardization to critical realism). Accordingly, this section will provide a very cursory review of Spash's critique followed by a more thorough critique of Spash.

Briefly, Spash divides ecological economists into three categories: new environmental pragmatists, new resource economists, and social ecological economists. The former two, according to Spash, are "shallow" expressions of ecological economics, whereas the last example is "deep." A (very) brief description of Spash's categories is as follows.

New environmental pragmatism

Spash's use of the term "pragmatism" in "new environmental pragmatism" should be understood in the vernacular sense, and without reference to the epistemological posture of American Pragmatists such as Dewey, James, and Pierce. Following Spash: "While new environmental pragmatism, as described here, is therefore a largely negative and shallow approach this should not be taken to imply philosophical American Pragmatism is necessarily tarred with the same brush." Indeed, at times, Spash promotes the Piercean concept of fallibilism; i.e., the "theory that it is impossible to attain absolutely certain empirical knowledge because the statements constituting it cannot be ultimately and completely verified" (Merriam-Webster). By contrast, Spash describes new environmental pragmatism as generally lacking in "any philosophical foundations" whilst favouring whichever "communicatively powerful statements" will maximize effective attention and engagement out of concern for environmental problems. For Spash, new environmental pragmatism emphasizes expediency above circumspection, disregards the relationship between theory and practice, and promotes solutions to environmental problems on "purely instrumental grounds" as opposed to a "fundamental critique of the dominant structure of political economy and its treatment of human relationships with Nature" (p. 355). Following Spash:

> Those who fall under my category of new environmental pragmatism are focussed on pushing methods and concepts because they are deemed to be effective under current

> political conditions and economic institutions (i.e., those of neo-liberalism and capitalism). These pragmatists want to sell their environmental message in an appropriately market-able form acceptable to political, business and financial elites, and in doing so buy into the methodology and ideology of commodifying, quantifying and pricing Nature. This form of pragmatic drive can be seen in a variety of work and use of concepts such as ecosystem service valuation, natural capital, Green accounting, carbon trading, and biodiversity offsets and banking (Spash, 2013,p. 354).

Beyond Costanza and Daily (i.e., the core proponents for ecosystem services in the EE discourse -, Spash perceives this group as predominantly environmental economists who choose to publish in the journal ecological economics out of a desire to capitalize on the journal's respectable impact factor, and without a stake in distinguishing the field as a separate and unique heterodox approach that challenges the core assumptions of orthodox economic theory.

> At the same time they have not been averse to publishing their own lesser and/or theoretically ungrounded works in Ecological Economics, which has a higher impact factor than most economics journals. This is why, for social ecological economists, the journal has for sometime had the appearance of being a dumping ground for second rate and duplicated papers from agricultural, energy, resource and environmental eco- nomics. Typically, as currently being practiced, new environmental pragmatism is about recommending monetary valuation and supporting a neo-liberal market approach for environmental policy (Spash, 2013, p. 360)[31].

For Spash, not unlike feminist economists or Marxian economists, an important contribution of ecological economics is that it exposes the irrationality of price theory. That is, according to critics of ecosystem services and other market-based approaches employed by environmental economists, the concept of profit is only coherent because key factors of economic production (i.e., labour, ecological processes, and women's work) are explicitly excluded or undervalued, and, in theory, if the totality of seemingly exogenous factors (i.e., "externalities") were successfully internalized within market models, the system would cease to function, and its intrinsic irrationality would be revealed (thus validating a

[31] This is a highly provocative claim, and one that I do not endorse by virtue of having reprinted it here. Rather, I include this quote simply to underscore the severity of Spash's antagonism towards "new environmental pragmatism". For a thoughtful critique of Spash's agenda to re-shape ecological economic discourse, see Farrell, 2018.

"weak comparability of values" and undermining the neo-liberal project; see Martinez-Alier et al., 1998). For Spash, one either accepts this reality, or one does not, and it is contradictory to argue, as Costanza does, on pragmatic grounds that "the choice between the environment versus the economy is a false choice" (Costanza 2006) if one adopts a methodology that promotes the implicit ontology in which the environment exists as a component within a more general and pervasive economic reality. Spash asserts that such pragmatic compromises "are detrimental to developing an alternative economic vision" and that proponents of market-based approaches "should do so elsewhere, and so free ecological economics from having to pretend to agree with a series of orthodox fallacies, including the pretence that there is no biophysical reality imposing limits and economics can be value free" (Spash, 2012, p. 46).

To conclude, the reader should note that Spash's "new environmental pragmatists" do not correspond to my own typological categories (p…). That is, I contend that payments for ecosystems services does not constitute an "ecological approach" in any sense (e.g. social bioeconomics or ecologism). Following Spash, I agree that PES is an expression of mainstream economism.

New Resource economists

Spash describes new resource economists as ecological economists that boast a "core faith in market-based systems as the best means for the delivery of democratic and free societies" (p. 356) with the caveat that markets should be "ecologically and socially constrained" through policy mechanisms such as, for example, tradeable emissions permit markets or "the allocation of rights to give birth"[32].

> This is often combined with a faith in, problem solving and life enhancing, new technology which is expected to be stimulated through market pricing. Thus 'getting the prices right' is the key way forward, rather than direct regulation of behaviour or structural change in social and economic systems. Within orthodox economics the nature of political economy is not regarded as in need of explicit attention, nor even of any relevance, but simultaneously the implicit faith in market systems as delivering freedom for individuals to fulfil their preferences makes for an easy alliance with neo-liberal politics (Spash, 2013, . 356).

[32] Both examples are from Daly. Note that Daly also generated significant controversy when he simultaneously proposed that families who were not allocated sufficient birth rights should have their children removed from them.

Following Spash, new resource economists are similar to new environmental pragmatists insofar as their thinking is "also embedded within free-market ideology and mainstream price theory," but the former is also potentially explicitly orthodox in the sense that they openly embrace the very market ontology that pragmatists, according to Spash, only implicitly promote so as to secure relevance and impact in the broader social consciousness. The true distinction between the two comes with a new "priority given to issues of ecological functioning" along with a "focus… on how to include ecosystem functions in economic models, … [using] them to derive insights into the operation of linked ecological-economic systems" (p. 357). As such, Spash is suggesting that "new resource economists" generally derive from realist genealogies of theoretical ecology that are concerned with conceptualizing coupled economic and ecological systems in terms of functional wholes (i.e., entities with structural and functional integrity) so as to produce formal, quantitative, predictive-representational models (i.e., ecosystems ecology/ systems ecology) that can help policy-makers to "maximize utility," "evaluate pay-offs" and "seek optimal solutions" to environmental problems. Spash notes, "In terms of methodology, the key approach is to use mathematical formalism to create abstract models which are then meant to explain aspects of reality. This follows the flawed mainstream approach of equating such deductive mathematical formalism with rigour and objectivity, something not even correct in the field of mathematics" (p. 357). Unsurprisingly then, Spash associates this group with "atomistic reductionism," "closer to renewable resource economics than environmental economics."

Similar to my own argument that ecological economics frequently blurs the lines between "thick and thin" complexity, Spash notes that new resource economists, despite their distinct preoccupation with formalism, identify as "post-normal" scientists (see Funtowicz & Ravetz, 1993, 2003; also see chapter 5 of this text) and promote the idea that ecological economics is a post-normal science despite their pre-occupation with privileging mathematical formalism. Following Spash:

> The blurring of the lines as to what is distinct about ecological economics is also something continually repeated in this journal. For example, recent claims by Silva and Teixeira (2011) that ecological economics is now a post-normal science appear based upon the antithesis of the post-normal philosophy (e.g., the spread of mathematical formalism, abstract expert modelling, and low quality uncritical monetary quantification) (Spash 2013, p. 356).

Within my own categorization scheme, I would refer to this group under the umbrella of "ecological economism" (i.e., proffering a faith in orthodox economic reductionism, undisrupted by a formalized interpretation of ecological processes), and the tensions herein reflect those I have outlined in my brief

critique of Norgaard and Costanza, although it is noteworthy that Spash includes neither of those authors in this category. Indeed, as I will explore in the next section, the position that Spash promotes (i.e., social ecological economics) also indirectly "blurs the lines" between the ontology of ecological economics with that implied by economic orthodoxy.

Social Ecological Economists

Spash defines social ecological economics as distinct from his other two categories in three key respects. First, social ecological economics is aims to address fundamental critiques of orthodox economic theory, and, as such, derives solely from a variety of heterodox genealogies, including Marxian economics, feminist economics, evolutionary economics, and/or welfare economics (note that Austrian economics is intentionally excluded due to its "ideological presumption that it makes concerning the central role of markets as opposed to other social and communitarian institutions" – p. 358). Thus, in effect, Spash proposes delimiting the pluralism of EE to a plurality of heterodox perspectives to the sole exclusion of the orthodox neoliberal-neoclassical perspective. Second, SEE necessitates epistemological perspectives that reject both reductionism *and* realism - to varying extents – so as to address value pluralism coextensively with biophysical limits.

> There is a distinct realist element to social ecological economics. This can be seen in criticism of orthodox economists as not facing the evidence of their own irrelevance to modern economic systems... *Part of this realism is to reject the atomistic reduction of wholes to parts*. That is, for example, to accept society is different from a collection of individuals just as ecosystems are more than a bunch of species or an animal just genes. The realist aspect does not totally exclude social construction but highly limits its role and excludes relativism. Neither does it mean we can know for certain what is true (i.e., it accepts fallibilism [*sic*]) (Spash, 2013, p. 357).

Third, SEE emphasizes that the world is evolutionary and mutable rather than constant and equilibristic. One will note that the rejection of atomism associated with the adage, 'the whole is more than the sum of its parts"[33], attributed to Aristotle, is conventionally associated with systems theory, and this gesture

[33] This popular adage is often attributed to Aristotle, although it is not a direct quote. The original text from *Metaphyiscs* reads as follows: "Concerning the challenge we just faced about how to describe things in numbers and definitions, What is the reason for a unity/oneness? For however many things have a plurality of parts and are not merely a **complete aggregate** but instead **some kind of a whole beyond its parts**, there is some cause of it since even in bodies, for some the fact that the there is contact is the cause of a unity/oneness while for others

serves as one of many indicators that Spash believes his evolutionary emphasis in SEE is very much aligned with systems ontology. Spash, for example, provides relatively few exemplars who closely reflect his ideal of a "social ecological economist", and most of them, including Gowdy and Erikson, Holling, and Norgaard (in addition to Spash himself, of course) are all outspoken proponents of complex adaptive system research. In addition to Norgaard, whose alignment with CAS I have already discuss, C.S. Holling, the progenitor of resilience theory in social-ecological systems discourse, is among the most influential complex adaptive systems scientists of all time. Similarly, Gowdy and Erikson, who strongly affirm Holling's views and have proclaimed that CAS represents ecological economics' version of marginal analysis.

> Specifically they note such things as episodic not gradual change, non-linearity in spatial scales, absence of equilibria, destabilising forces, uncertainty and unpredictability. In social and economic systems such features and their comprehension are highly relevant for understanding the modern environmental predicament and the failure of orthodox economics (Spash, 1999). Others have emphasised the importance oft he co-evolution of social, economic and natural systems (Gowdy, 1994; Kallis and Norgaard, 2010; Norgaard, 1994), and complexity leading to recognition of emergent properties (Kay et al., 1999)[34].

In practical terms, then, Spash's descriptive vision of how SEE has historically manifested seems to amount to heterodox economists who embrace complex adaptive systems methods in tandem with a non-specified epistemological posture that rejects relativism but acknowledges fallibilism. Spash's normative vision for SEE (and for the field of ecological economics itself) attempts to unify the desirable features of social ecological economists within the broader philosophical framework of critical realism. The core assumption, however, is that critical realism accommodates all three components of SEE, and it is this prescription that I will challenge in the following section.

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there is viscosity or some other characteristic of this sort. But a definition [which is an] explanation is one [thing] not because it is bound-together, like the Iliad, but because it is a definition of a single thing."

[34] As with Norgaard and Costanza, the sources Kay invokes to cursorily discuss complexity and systems are significant as they indicate what interpretation (or lack thereof) of complexity the author is implicitly endorsing. In general, Kay and his co-authors promote "thick-epistemological" interpretations of complexity vis-à-vis references to, for example, Casti (1999) or Allen (1992), both of whom subscribe to Rosen's thick interpretation of complexity that rejects CAS' concept of complexity as something that is, in principle, computable. In this particular piece by Kay et al., however, the authors promote a "conventional" interpretation of complexity in which the lines between thick and thin interpretations are unfortunately blurred.

2.3.5: Unity and Antagonism in Ecological Economics

Spash's proposal for the "new foundations of ecological economics" contains numerous tensions and contradictions. Although he upholds Norgaard as an exemplar of SEE, he also casts Norgaard's methodological pluralism" as a mistake in the course of EE discourse, noting that "calls for unity and/or union seem to rather gloss over the fundamental ontological, epistemological, methodological and ideological reasons for the division from orthodox economics occurring in the first place." However, rather than rejecting the idea of unity wholesale, Spash is simply calling for a different kind of unity: i.e., the unification of ecological economics around a core set of ontological commitments, epistemological assumptions, methodological positions, and ideological beliefs (see Spash, 2012, p. 45) that uniquely preclude the inclusion of orthodoxy.

In general, I will forego critiquing his proposals for epistemology, methodology, and ideology[35], and I will instead focus on Spash's preoccupation with ontology.

> If a new epistemology is required then it must be a break from the past and those groups which defend the old order. There are good reasons why this should also be a break and not an ever persisting party of antagonists in the big tent. A new preanalytic vision will not be sustained by those with opposing ideological positions or those who maintain a conflicting ontology (explicitly or implicitly) (Spash, 2013, p. 359).

Spash's analysis precludes the possibility of ontological pluralism; he posits an implicit duality between antagonism and unity where ontology is concerned. Although Spash acknowledges the need for a complementarist perspective that "accepts neither the scientific reduction of the natural environment to its physical characteristics, nor the constructivist position which denies biophysical constraints on social life" (from Jacobs 1996, as quoted in Spash 2012, p. 43), he rejects the most popular source of complementarism in ecological economic discourse: post-normal science.

> Post-normal science postulates that knowledge about a physical reality can be known through experimentation under restricted conditions (broadly in accord with logical empiricism) but that the realm of such knowledge creation is limited, and increasingly so. Thus, as we move away from the controlled laboratory, and physics, towards complex

[35] The one exception is Spash's "ideological" contention that "restrictions are necessary on population growth and the scale of human activity". I accept the idea that the "scale of human activity" is finite, but I reject Spash's preoccupation with population control (see Malm & Hornborg, 2014).

> interactive global systems, and environmental problems, we need a different basis for creating knowledge which involves broad participation by the lay public, as an extended peer community (Funtowicz and Ravetz, 1991, 1994). The problem with this approach, in the current context, is that it does not provide a clear theory of science, but is rather an attack on the practice and rhetoric of modern science. There is in part a prescriptive epistemology in that critique, but one that leaves unanswered the role of traditional science (i.e. is even restriction to some physics laboratory valid, or is all science really post-normal?). The ontological presuppositions are vague but seem to cluster around complex systems theory (Kay et al., 1999)[36].

Satisfied that he has disposed of PNS as a valid epistemological orientation that should underwrite the complementarism of contemporary "social" ecological economics, Spash then proposes to replace it with critical realism.

> One possible aid in developing an ecological economic preanalytic vision of those boundaries is to appeal to critical realism, which also aims to provide an understanding of the interaction between physical and social systems. Critical realism accepts that we can never demonstrate that we have discovered the truth even if we have (fallibilism), but does not reject the idea of there being an underlying objective reality. *The description under critical realism is of an ordered hierarchy of sciences e.g. molecular sciences, biological sciences, social sciences* (Collier, 1998b). There is real (ontological) difference in the strata so they are not regarded as just cognitively (epistemologically) convenient. The real distinctions between the strata, and their irreducibility one to another (contra reductionism), are used to explain distinctions between the various sciences and the reason for a plurality of sciences to exist. So, for example, everything is governed by the laws of physics, all biological entities are physical but not vice versa, so biological sciences are embedded within the physical and likewise the social within the biological and the

[36] I have thus far avoided discussing post-normal science mainly because I embrace it and I will discuss it length in chapter 5. For my purposes, this quote not only summarizes Spash's position, but also, I maintain, it provides the reader with an apt and succinct description of PNS and its goals. Note, however, that I strongly reject Spash's criticism that post-nromal science is vague with respect to its ontology of science. Similar to Kay (see footnote 20), Funtowicz and Ravetz's theory of science is predicated on a concept of "emergent complexity" that is, they argue, equivalent to Casti's (1992) concept of complexity. Once again, Casti's complexity derives *directly* from Rosen's (1985, 1991) theory of the modelling relation. Post-normal science is, therefore, predicated on "thick" complexity that explicitly (not vaguely) distinguishes between that which is computable and that which is not. These concepts will be further explicated in chapter 5 of this text.

> economic within the social. This type of embeddedness is one of the key messages ecological economists have been at pains to communicate i.e., the economy is embedded in the Natural environment and subject to the Laws of Thermodynamics. Yet, embeddedness should not be confused with reductionism. That elephants are constructed of physical and chemical components does not mean elephants' behaviour can be understood by analysis of or reduction to those components (emphasis mine) (Spash, 2012, p. 43).

Here, I will not comprehensively critique every aspect of critical realism - particularly because the various proponents of CR (e.g., Lawson, Bhaskar, Collier) present a range of different visions as to what CR actually engenders. Furthermore, I do not take issue with the "retroductive" methodology of critical realism that attempts to explain phenomena by postulating explanatory mechanisms and systematically eliminating possible explanations (see Bhaskar 1979). Rather, I will restrict my critique to the feature that Spash proposes is most germane to ecological economics: the ontological hierarchy suggested by critical realism.

At face value, there is much that critical realism has to offer ecological economics. By insisting that the strata are ontologically separated, critical realism is (allegedly) anti-reductionist whilst also providing affordances for the biophysical dimension broadly ignored by orthodox economics. Notwithstanding the fact that there are a variety of epistemological traditions that also purport to walk the line between crude realism and incoherent relativism (which is generally a red herring, in my opinion), the main question I have is, what is lost, or what risks do we run when we impose a hierarchical ontology on reality?

First, the issue with ordering ontological strata in a hierarchy is the assumption that strata are ordered in the proper sequence. Spash proposes the same ranking that is proposed by the Marxist theorist Andrew Collier, and the direct quote from Collier (1998) is as follows:

> ?
> psychological and semiological sciences
> social sciences
> biological sciences
> molecular sciences

?[37]

(Collier, 1998, p. 260).

Because there is no rote means of ordering such a strata, doing so involves normative decision-making that is implicitly value-laden. For example, Collier's tree of sciences assumes that sociology is prior to semiology, although there is substantial debate among semiologists and linguists as to whether semiotics is innately biological. One will also note that biosemioticians – not unlike organicists, emergentists, and general system theorists before them - hold that semiotics provides a paradigm for a general theory of biology and, as such, should be considered as "prior to" biology and the social sciences. Systems biologists, such as Rosen, have long insisted that biology has the potential to provide insight into physics, although that should not suggest that Rosen viewed nature as hierarchically ordered. Rather, for Rosen, the divisions between the sciences are conventional rather than either reified or simple matters of convenience. They are separate models of an inherently complex reality, made complex by immutable epistemological boundaries implied by the limits to mathematical formalism and logical entailment. One idea I have introduced in this chapter (and will expound on in Chapter 5) is that Rosen's interpretation of complexity is synonymous with "thick" complexity. Thus, the critical realist position precludes thick complexity in favour of thin complexity. The question, however, is how critical realism accommodates "thin" complexity within its ontological hierarchy.

This brings us to my second critique of critical realism. Note that the ontological strata proposed by Spash (vis-à-vis Collier) all conform to historical European disciplinary categories (e.g., molecular sciences, biological sciences, social sciences, etc.), and this assumes Westerners got the categories right in the first place. Most forms of fallibilism and constructivism are figuratively "anti-colonial" insofar as they de-naturalize the boundaries between the European academic disciplines, marking them out as essentially arbitrary. That is, we cannot objectively or intuitively determine the dividing line between, say, physics and chemistry or sociology and ecology, and it is not inconceivable that, for example, a non-European culture might have constructed an elaborate system of explanatory models, bespoke with their own disciplinary categories, that bear no resemblance to those invented by Europeans, but with equal or greater predictive efficacy. The purported epistemological fallibilism of critical realism would seem to support this view, but any subjectivism is effectively rendered moot by re-casting European

[37] Note that this list appears as it was written in the source material - including the question marks – which should suggest among other things that critical realism is still very much a work in progress.

epistemological categories as ontological commitments (which, like articles of faith, are non-verifiable). The result is a speculative metaphysics that both ossifies and reifies the Western intellectual tradition. By extension, critical realism is an inherently colonial ontology that is unable to accommodate non-European cosmologies that do not subscribe to the ways in which colonial imaginaries segment reality.

Farrell's (2018) critical review of Spash's *Routledge Handbook of Ecological Economics: Nature and Society.* Farrell notes that Spash inappropriately suggests that critical realism constitutes the "foundations" of EE research, though precisely none of the "proto" ecological economists (e.g., Boulding, Odum, or Georgescu-Roegen) espoused critical realism. From Farrell: "[Spash and his contributors presume] the existence of something they refer to as 'Nature', which is presumed to exist beyond the reach of human understanding and is fixed and immutable in its reality. This is a Platonic presumption, repeated in the work of Aristotle and later confronted, in the context of social science, by Max Weber (Weber 2004). It implies not only that there are right and wrong ways to make sense of the ecological economic Gestalt (Farrell and Silva Macher, 2017) with which I am in full agreement but also that the *monistic euro-descendent epistemology that presumes an a priori distinction between real and not-real* is universally applicable. In place of responsible recognition of the normative implications of actively engaging the hermeneutically complex challenge of supporting contemporary humanity in reshaping a globalized life-world, *we are left with normativity masquerading as objectivity*" (p. 165-166, emphasis mine).

Further, critical realism's ontological approach only half counters the underlying problems associated with reductionism. For the early 20th century biological theorists who sought alternatives to reductionism (e.g., Bergsen, Smuts, Uexkull, or Cannon), the issue was not only that reductionism was reductive but, moreover, that it reduced "softer," and often idiographic, sciences (e.g., biology, sociology, or ecology) to sciences that were distinctly nomothetic (i.e., deterministic according to invariant laws). By contrast, critical realism uniquely addresses reductionism whilst still providing affordances for social and biological determinism within the social and biological strata. This is why in various other epistemological traditions in biology, such as British emergentism or general systems theory, were more concerned with *physicalism* than reductionism per se. It is, in other words, less problematic to promote an isomorphic, biological-view-of-society if and when one's theory of biology is relational, reflexive, and ontologically indeterminate. Contrary to physicalist-reductionism, General System Theory sought to turn the "tree of sciences" on its head by demonstrating isomorphism between general patterns found in open systems, and then applying discoveries in, for example, psychology,

semiotics, and sociology to general physics (Boulding 1956). Similarly, the philosophical traditions surrounding emergentism (e.g., Henri Bergsen, Alfred North Whitehead, or William James) sought similar methods to demonstrate the universality of subjectivity and experience, thus introducing the idea that all phenomena are idiographic to some extent. This idea is commonly referred to as "hylozoism"; the idea that all matter is experiential and lively. (One will note that this concept flourished in non-European cosmologies such as (but not limited to) animism, Buddhism, Hinduism, and Daoism millennia before it was adopted by British Emergentism and cybernetics shortly thereafter).

Critical realism, by contrast, makes affordances for monologism and determinism so long as the "laws" governing one stratum do not dominate other strata (i.e., reductionism). This means that one can espouse social determinism without having to concern oneself with anti-determinism in, for example, the fields of genetics, non-equilibrium thermodynamics, or particle physics. Foster and Clark, for example, promote Odum's social determinism of maximum empower, but, unlike Melgar-Melgar and Hall, they attempt to tempter their position with an epistemology of "realist-constructivism" that is critical of "crude empiricism, mechanism, naturalism, and essentialism":

> [Marx's] work was highly critical of crude empiricism, mechanism, naturalism, and essentialism (i.e., positivism), while remaining materialist in orientation. Unlike crude naturalism, it takes into account the human construction of knowledge, but unlike the absolutist constructionism of strong idealism, its constructionism always takes account of and is tempered by the "materialist principle," "which derives from the fact that people are themselves material, animal and part of nature such that they are subject to certain of its causal laws and conditions" (Sayer, 1992, p. 34).

There is a clear logic behind this approach to Odum. He was, after all, a Marxist (Odum and Scienceman 2005), and critical realism has roots in analytical Marxism. Among Marxists, it is sometimes claimed that critical realism extends the epistemological ethos of Marx himself, so if analytical Marxists retroactively apply the moniker of critical realist to Marx, then why not apply the term to other Marxist theorists? Although such an approach to Odum's theory is marginally more self-conscious than the "crude realism" of Hall, ultimately, some new and some old problems arise. What meaning does social constructivism have alongside the idea that progressive social evolution constitutes an immutable "causal law"? To paraphrase Mark Sagoff, this is an example of the "hybrid reverting to form" - a case in which lip service is paid to anti-realism, but only performatively. Critical realism cannot dismiss the inherent incompatibility between social constructivism and social determinism, so instead, it sidesteps the issue

with strata whose boundaries effectively insulate historicist claims against traditional critics who insist that historical materialism is a form of reductionist economism that disdains theories of culture and politics. (Note that I do not categorically embrace such critiques of Marxism, although chapter 4 of this text will attempt to demonstrate how Foster's "dialectic" between Marx and Odum constitutes a form of "functionalist Marxism" that is no less problematic for environmental justice, critical realism notwithstanding).

Furthermore, by invoking the "principle" of maximum empower, which supposedly governs all manner of dynamics (political, social, cultural, etc.) pertaining to systems across any number of ontic strata, this would seem to contradict the whole purpose of arguing for separate and discrete ontic strata with self-contained rules. This highlights how critical realism struggles to incorporate meta-theoretical systems concepts (e.g., complexity, emergence, or self-organization) within a stratified, pluralistic[38] ontology. As noted, there are both ontological and epistemological interpretations of complexity. Spash explicitly subscribes to the former, noting that ecological economists should adopt the "ontological presupposition" that "complex systems and their interactions create emergent properties and are inherently unpredictable" (Spash, 2012, p. 45). Indeed, many authors whom Spash promotes as "social ecological economists" (e.g., Norgaard, John Gowdy, Jon Erikson, and C.S. Holling) champion the very same complex-adaptive-theoretical premises as authors he derides as "new resource economists" without realizing that complex adaptive systems theory directly derives from the boolean cellular automata of Jon von Neumann, which constitutes a significant theoretical cornerstone in what Philip Mirowski calls the "neoliberal thought collective" (see Mirowski, 2002). Repeatedly, albeit indirectly, Spash points to either "thin" (i.e. CAS) or "conventional" interpretations of complexity (Kay et al. 1999). In either case, Spash clearly interprets complexity as a matter of ontology, and this interpretation necessarily complicates the implications of adopting critical realism.

First, Spash does not seem to grapple with the consequences of interpreting systems concepts (e.g., complexity, emergence, hierarchy) as matters of ontology. For example, uncertainty is not an ontological commitment in and of itself. Rather, uncertainty can manifest in a variety of ways depending on prior ontological commitments or epistemological assumptions. There can be high uncertainty in

[38] In this context, the term "pluralistic" refers to the concept of ontological pluralism which does not necessarily invoke the same political or ethical connotations associated with the interpretation of political, disciplinary, or ethical pluralism used in most of this text. A pluralistic ontology simply means an ontology with many types of ontic objects, as opposed to a "monistic" ontology in which reality of composed of one essential type of object (e.g., Gottfried Wilhelm Leibniz's "monads'). It is entirely possible for a pluralistic ontology to be anti-pluralistic in, for example, the political and cultural interpretations of the term.

otherwise deterministic systems (due to the impossibility of precise measurement), or there can be high relative certainly relating to non-deterministic systems (i.e. systems involving purposive agents who have communicated an intention to do something that is more or less uncomplicated). Likewise, there might be uncertainty pertaining to a system involving purposive agents if those agents keep their intentions to themselves. There is also the possibility that nature is aleatoric – i.e., causally underdetermined - whereby uncertainty is the result of truly random occurrences (Prigogine and Stengers 1985). And, of course, all of these possibilities might be coextensive within a single situation. The answer to the question of "why" there is uncertainty in nature (a question that Spash ignores) pertains to ontological considerations (e.g., agency-structure dualism) that are highly relevant to theoretical ecology and political economy in equal measure.

Secondly, if complex systems are ontological objects, and if critical realism organizes its ontological objects under a stratified hierarchy, then which stratum do complex systems belong under? Is Spash suggesting that the science of complexity constitutes its own stratum in which specific laws, principles and regularities govern the behaviour of complex systems?[39] There are indeed many "systems scientists" who support such an implicitly ontological approach to systems theory, although systems science generally includes biological, sociological, and psychological phenomena under a common, metatheoretical category (i.e., the umbrella of "general systems"; see Bertalanffy, 1950; Boulding, 1956; Hempel, 1951). Alternatively, one might suggest that systems principles supersede the strata themselves, and, indeed, this is one way to interpret Bhaskar's use of the concept of autopoiesis (i.e., the process by which complex systems "self-produce")[40]. On the other hand, Bhasker describes the process by which strata (i.e., discrete ontic topological domains) are formed as "semi-autopoietic", and, once again, this assertion creates a curious contradiction at the heart of critical realism: if semi-autopoiesis semi-governs the formation of strata, then which ontological stratum governs autopoiesis? Is critical realism a pluralistic ontology due to its plurality of ontic strata, or is it a monistic systems ontology because the formation of the strata themselves are determined by the same semi-autopoietic

[39] Note that many systems scientists do support this position.

[40] For reference, Maturana and Varela's definition of autopoiesis is as follows:" An autopoietic machine is a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in space in which they (the components) exist by specifying the topological domain of its realization as such a network." (Maturana and Varela 1980).

processes? Furthermore, for Maturana and Varela, autopoiesis is a distinctly biological concept explicitly not intended for use by social theorists, and it is a matter of substantial debate as to whether the concept should be extended to, for example, psychological, sociological and political processes as well. Bhaskar, by contrast, seems to be suggesting that autopoiesis is a general feature of all reality, but it is difficult to say for certain because his use of systems concepts (e.g., emergence) is generally metaphorical and vague. Ultimately, by drawing attention to these tensions and contradictions, I only mean to suggest that the synthesis of critical realism and the systems concepts native to theoretical ecology is fraught with difficulties. Following Farrell (2018), this is perhaps why there is no tradition of critical realism in ecological economics prior to Spash.

The final critique I have does not directly relate to the relationship between critical realism and systems theory, but it does speak to the ways in which critical realism uniquely precludes potentially generative philosophical orientations, including, but not limited to, the emergentist organicism that underwrites "thick" complexity. Critical realism is comparatively rare in heterodox economics outside of Marxian economics and Marxist political economy. If EE is standardized around critical realism, then it would force heterodox economists to adopt CR in order to engage with EE. Intriguingly, such demands are not without precedent in heterodox economic circles. Tony Lawson, a leading critical realist, notably attempted to persuade feminist economists to adopt critical realism years before Spash proposed the same for ecological economists. Following Juniper (2003, p. 1), Lawson was broadly unsuccessful and "few of the feminist respondents were convinced by Lawson's arguments that their interests would be best served by espousing a Critical Realist ontology in debating with orthodoxy." Harding responded that feminist economists generally avoid ontology in favour of epistemology precisely due to the ubiquity of the "naïve realism" held by conventional researchers. For Harding (2010), naïve realism (i.e. the view of "all reality as fixed, science and knowledge as somehow value- and interest-free or neutral, as well as necessarily convergent on truth regarded as objective") constitutes an implicit ontology in and of itself. She recognizes that "it requires a great deal more than "clear thinking" to dislodge such ontologies from their status as obvious" (p. 130). Feminist economists both operate in close proximity to natural scientists just as their efforts are routinely ignored by mainstream researchers. Thus, for Harding, like the "pragmatists" that Spash disdains, "decisions about which argumentative path to pursue will be strategic ones" (Harding & Harding, 2010, 132). From this perspective, Spash's distinctly limited proposal for pluralism in EE would result in either excluding feminist economists altogether or paternalistically compelling them to adopt an ontological posture they have generally declined to embrace in order to engage with ecological economic discourse.

Julie Nelson (2003) has provisionally accepted Lawson's call for ontological theorizing in feminist economic discourse – reasoning that "one's thinking is in fact rooted in ontological beliefs" – while also rejecting the suggestion that feminist economist ought to adopt critical realism specifically. Consistent with Norgaard and Georgescu-Roegen, Nelson proposes that neoclassical economics is based on "a view of the world as a closed system of laws and mechanisms, populated by atomistic agents, value-free, and of a shape and quality that can be usefully probed with our tools of mathematical theory and econometrics." Because feminism is grounded in opposition to "oppressive and unjust structures," it follows that feminists "interpret the world as open, interrelated and flexible." Crucially, feminist economists recognize that the fact-value dualism inherent to the naïve realist ontology reinforces and reproduces structures of oppression in the same way that ecological economists recognize these elements in the exploitation of nature. Although critical realism casts itself as "liberatory," Nelson remains unconvinced that it is suitable for feminist economics on the grounds that CR, like conventional approaches, privileges "reason, abstraction, and precision over emotion, particularity, and what is vaguely known." She continues that 'unless "emotion" – and indeed, "value" itself – are present in the core of what we believe about how the world works, care and emotion will never overcome their status as mere add-ons."

As an alternative, Nelson suggests Alfred North Whitehead's "Philosophy of Organism" as an ontology that would greatly benefit both ecological economists and feminist economists for two primary reasons. First, and very briefly, Whitehead's epistemology is one of "provisional realism" that Nelson summarizes as follows:

> …while we can admit to knowledge only what we know from experience (as an empiricist would posit), because reality interpenetrates and because our experience includes broad, vague feelings of influence and efficaciousness, we are confident that items and relations outside us exist (as a realist would posit) (Nelson, 2003, p. 115).

This position effectively maintains fallibilism whilst deflecting crude relativism (i.e., identical to the two features of critical realism that Spash affirms as paramount for ecological economics). Furthermore, Whitehead's philosophy affirms experience, and thereby "feeling" as the "fundamental unifying reality," thereby addressing the "bifurcation of nature" associated with mind-body dualism and the significant ontological problems associated with it. It is for this reason that proponents of "thick," humanist approaches to complexity (e.g., Prigogine) both endorsed Whitehead's metaphysics and rejected "thin"

approaches to formalized complexity such as cellular automata (see Guerra's 1996 interview with Prigogine).

I use Nelson's article as a key example in part because I also endorse Whitehead's ontology (a recurring theme further into this text). Whitehead is a commonality between many of the theoretical postures I seek to draw connections between, including entangled humanism, relational holism, and rhizomatic pluralism. Whitehead is uniquely embraced by post-structural philosophers and political theorists (e.g., Deleuze and Guattari, Isabelle Stengers, William E. Connolly, and Bruno Latour) and contemporary theoretical/systems ecologists alike because, as I will explain, the "humanist" genealogy in systems theory derives from process ontology and British emergentism as opposed to structural functionalism. Although I do not endorse Whitehead's process-relational metaphysics as a "standardized" ontology for ecological economics or any other environmental transdiscipline, I nonetheless contend that "thinking with Whitehead" is a potentially fruitful exercise for transdisciplinary engagement between sustainability science and environmental justice. Once again, these themes will be explored in chapter 3, but for now, the broader point is that there are alternatives[41] to Spash's "critical pluralism" that would not exclude potentially generative ontologies whilst making affordances for deeply problematic ontologies (i.e., Foster's functionalist Marxism). Spash, in calling for standardization, seeks to abolish conflict between antagonists with competing ontologies, but one must ask whether this exchange is worth the price given what it excludes versus what it permits.

2.5 "Recentering Justice" in Ecological Economic Discourse

By way of summary, I will juxtapose these four previously critiqued approaches with a fifth approach - i.e., recentering justice in EE - that I will not critique so much as illustrate how it is: 1) incongruent with the four dominant proposals for "future" EE discourse, and; b) lacking in any unique theoretical framework that would enable the congruence it proposes. Briefly, multiple authors have called for both a recentering of justice as a pillar of ecological economic discourse in combination with a closer and more integrated relationship between ecological economics and political ecology (Kolinjivadi 2019; Spencer et al. 2018). (Note that this impulse is shared widely within the "Degrowth" sub-discourse of ecological economics, and is particularly, but not exclusively, popular within the traditionally socially minded European tradition in EE). To achieve this, Spencer et al. (2018) argue that ecological economics must embrace "polycentric, pluralistic, open, rich, and heterogeneous ideas need to be expanded in

[41] Piercean pragmatism; Nietzschean perspectivism; Poincare's conventionalism, to name a few.

ecological economics to counter impulses to revert or default to neoclassical frames and monolithic theories (p. 152).

The four competing perspectives that I have critiqued all disguise the implicit, functionalist social ontology shared between *specific interpretations of* systems-theoretical-ecology on the one hand and orthodox economics on the other. Insofar as all four approaches contain some measure of positivism, realism, anti-humanism, social determinism, and unificationism, they are also all problematic, to varying extents, for pluralism between sustainability science and environmental justice. The common thread between the various proposed agendas for future EE is that all four approaches employ subtle discursive practices concerning complexity that either promote or create conspicuous affordances for neoliberal orthodoxy or "monolithic theories" of everything (or both).

Costanza's deliberative democracy emphasizes consensus and claims that complex problems are problems that do not lend themselves to discourse and debate. In this respect, Costanza's understanding of complexity is drastically under-theorized. On the one hand, he contends that complexity engenders "multiple perspectives." At the same time, he simultaneously argues that complexity engenders a specific perspective on how complex systems, societies, for example, function and fail. The "fact," in his view, that societies constitute complex adaptive systems that collapse when they experience prolonged periods of diminishing returns on invested resources is, according to Costanza, a matter in which disagreement is inappropriate. The purpose of pluralism, like complexity, is ultimately to eliminate itself through consensus building as multiple perspectives coalesce to address common problems and build "the world we all want."

Norgaard's methodological pluralism, by contrast, is too porous (i.e., "indifferent") insofar as it opens many doors to the neoclassical/neoliberal economic hegemon. Chiefly, Norgaard fails to distinguish between what it opposes and what it endorses. Although he claims that the "ecological view" is distinct from the economic view, he duly notes the historical, epistemological connections between the two, and he does not tell us precisely *how* the two differ except with vague reference to an ill-defined ethos of ecologism. Rather, what Norgaard promotes always contains traces of what he purports to oppose; for example, situating the problem of economism in positivism on the one hand whilst arguing in favour

of intellectual “natural selection” as the only means of filtering “good” arguments from “bad” arguments in ecological economic discourse.

Melgar-Melgar and Hall’s proposal promotes reductionist functionalism and social Darwinism. They draw a false equivalence between the second law of thermodynamics and the Odum-Lotka principle of maximum empower. They argue that EE is compelled to embrace the latter as an organizing principle not only to deter the influx of environmental economists in EE discourse but also to establish biophysical economics as a dominant voice within a “tiered” transdiscipline. For Hall, complexity is a problem to be solved as opposed to the idea that some problems are intrinsically insoluble. Complexity, they argue, “disappears” once social theorists accept that history is “nothing but” the unfolding of an energetic process in which more efficient entities naturally dominate less efficient entities. Multiple perspectives are permitted, but the biophysical perspective must be privileged. Melgar-Melgar and Hall’s approach is definitionally anti-pluralist. It is also profoundly dangerous.

Spash’s proposal counters Norgaard’s “uncritical pluralism” but creates unique affordances for Melgar-Melgar and Hall’s reductionist functionalism. Ultimately, Spash’s proposal mirrors Costanza’s in that it assumes unity through methodological standardization and critical realism is the only solution to a big tent of antagonists with conflicting ontologies. Although Costanza seeks to exclude the malcontents (i.e., the argument culture) and Spash seeks to exclude the orthodoxy, both seek to dimmish internal conflict by collapsing the “big tent” into a smaller, more manageable circle of consensus. Neither considers the potentially productive capacity of contention, debate, and conflict (i.e., agonism).

Although all four of these positions make performative gestures in favour of social justice, they also do so while uncritically promoting often vague interpretations of systems theoretic ideas. The proverbial elephant in the room is the historical antipathy between systems theory and social theory (Bell 2005; Bell and Bellon 2018; Berlinksi 1978; Bookchin 1983, 1995; Ghani and Wolf 1987; Hornborg 2009; Jackson 2000; Lilienfield 1978; Merchant 2005, 1996; Mirowski 2002; Peluso and Watts 2001; Sagoff 2015; Taylor 1988, 2005; Walker 2020; Watts 2014), and this antipathy severely complicates the relationship between ecological economics and its closest social theoretic, allied disciplines; namely, but not limited to social and political ecologies. All four positions contain features that either preclude entirely or fail to adequately accommodate the possibility of pluralistic engagement with political ecology and environmental justice.

Chapter 3: Life as Ideology

3.1: Political Ecology and Sustainability Systems Theory

The antipathy between political ecology and systems ecology must be understood within the context of a prior and more pervasive distrust of systems ecology by social theorists in general (and environmental social theorists in particular). Political ecology is unique within environmental social sciences and humanities in that it distinguished itself as a discrete social theoretical discourse by explicitly rejecting applying theoretical ecology to social theory. As Watts (2019) explains, political ecology grew out of earlier discourses in cultural ecology and ecological anthropology, both constituting the application of systems ecological theoretic as explanatory models of social phenomena. Critically, early cultural-ecologists-turned-political-ecologists, such as Wolf, Watts, and Godelier, rejected structural functionalism in environmental social theory, and they viewed the application of systems and cybernetics to social theory as both the de-politicization of ecology, as well as the disciplinary imperialism of the natural sciences into the social.

Following Godelier:

> Here [in cultural ecology and ecological anthropology] we recognize empirical materialism, the *"economism" that reduces all social structures to nothing but* epiphenomena of the economy which is itself reduced, through technique, to a function of adaptation to the environment … a materialism like this is unable to explain the reasons why, the fundamental necessity of what exists, i.e. the reasons why the history of societies that are not always completely integrated totalities but totalities whose unity is the provisionally stable effect of a structural compatibility that enables different structures to reproduce themselves until they reach the point at which internal (and external) dynamics of these systems forbids this totality to go on existing as such. (Godelier, 1972: xxiv-xxv, Emphasis mine).

Political ecologists rejected the rise of "adaptation thinking" in cultural ecology and ecological anthropology – introduced by Gregory Bateson and then fully realized in Roy Rappaport's highly impactful text, *Pigs for the Ancestors* (Rappaport 1987 [1968]). Rappaport interpreted indigenous societies in New Guinea as adaptive cybernetic-ecological systems whereby the periodic slaughter of excess domesticated pigs (whose maintenance represented a considerable overhead in terms of labour) served as a negative feedback loop that stabilized the system. Despite the book's popularity and despite

his objections, Rappaport's study was widely criticized as functionalist and for purportedly denying that the New Guinean villagers were capable of agency. Thereafter, adaptation thinking and cybernetics became closely associated with structural functionalism, and contemporary social theorists often draw distinct parallels between *Pigs for the Ancestors* and the discourse of Resilience Thinking after the systems ecology, C.S. "Buzz" Holling and his profoundly popular theory of a four-phase adaptive cycle that governs social-ecological systems (a.k.a. "Panarchy," see Folke et al., 2004; Gunderson & Holling, 2002; Holling, 1973, 2001; Holling et al., 2014) that builds on the complex adaptive systems research of the Santa Fe Institute (Gell-Mann 1995, 1997; Kauffman 1993; Levin 1999). Following Watts:

> Resilience provides both a normative and conceptual frame in complexity theory's deployment in global climate change analysis: adaptive capacity builds enhanced resilience. A four-phase "adaptive renewal cycle" (panarchy so-called) undergirds a capacious model of "socio-ecological systems analysis" drawing within its circumference, according to its in-house theoreticians, all that has gone before (Smit and Wandel 2006; Gunderson and Holling 2002)… And yet it was precisely the limits of adaptation as a form of thought which constituted the very ground on which political ecology emerged during the 1970s and 1980s. Minimally one needs to ask: is this old wine in new bottles? How and in what ways does "adaptation 2.0" address the weaknesses of "adaptation 1.0"? (Watts, 2014, p. 21).

As always, the concern voiced by political ecologists relates to what Giddens calls, the "imperialism of the social object"; a concept of objective holism that eliminates agency by reducing - "drawing within its circumference" - agential subjects to mere components within a capacious, integrated whole; the idea that a system is "nothing but an epiphenomenon" of the nomothetic processes that govern its dynamics. As discussed, some systems scientists did indeed adopt the position that systems were "nothing but" patterns of positive and negative feedback. However, this position is comparatively rare in the grand scheme of systems and cybernetics, particularly where social systems theory is concerned. Rappaport, along with his mentor, Andrew Vayda (Vayda and Rappaport 1968)[42], both rejected the characterization of ecological anthropology and cultural ecology as "new functionalism," in part because the "models" they proposed were qualitative and contingent, "explanatory sketches" as opposed to the

[42] Vadya was an outspoken critic of political ecology *and* metaphysical holism (which he associated with Rappaport's cybernetic approach to ecosystems).

predictive, operational models of, for example, the limits to growth[43] or Odum's formal energy systems language. Furthermore, for Vayda and Rappaport, the distinction between second-order-cybernetic approaches to cultural ecology and functionalist approaches to ecosystems ecology (with implications for social theory) was a distinction between functionalist "determinism" and interpretive "possibilism." Environmental determinism, they explained, is the position that "environmental forms dictate cultural ones and therefore cultural phenomena can be explained and should be predictable to a large extent by reference to their contemporary environments" (p. 479). Possibilism, on the other hand, maintains that "only the absence of traits (for instance, "the absence of pineapple plantations in Greenland") could be predicted from characteristics of the environment" (p. 479). Vayda and Rappaport rejected environmental determinism and structural functionalism, but, rather than adopting possibilism, they opted for a middle ground position in which "both classes of factors and the interplay between them" were recognized (thereby anticipating the contemporary sociological paradigm of "structuration" (Giddens 1984)). From this viewpoint, Rappaport recognized "functional" social and cultural structures, but he did not recognize them as a necessary outcome of selective pressure exerted by an environment on society. Once again, this approach precludes the possibility of prediction:

> The implication is that a demonstration of function provides by itself no adequate answer to the question of why some particular traits rather than others occur at particular times and places. For the student of functions, the characteristic question necessarily is "How does it work?" rather than "Why is it present?" or "How did it get this way?" (Vayda and Rappaport 1968, p. 496).

The confusion surrounding modern social-ecological systems theory – dominated by resilience thinking and complex adaptive systems thinking - is arguably much worse in part because such distinctions - i.e., between possibility and determinism or functional explanation and functionalism – are so often overlooked.

[43] Rappaport claims that the Pigs study was developed out of a criticism of functionalism and by no means adhered to functionalist doctrines. Indeed, most cyberneticians rejected functionalism. Bateson is widely acknowledged for his rejection of a correspondence theory of truth (i.e., "the map is not the terrain"), and, indeed, such an anti-realist posture is not only a general precondition of second-order cybernetics (e.g., Maturana and Varela), it was also more common than not amongst classical cybernetics (e.g., Wiener and Beer; see Pickering, 2011). Nonetheless, even Bateson's vague references to a "pattern that connects" are, for many, enough to undo his very explicit epistemological caveats.

Where resilience thinking is concerned, the situation becomes further muddled, as the "buzz-wordification" of the term "resilience" has engendered a plurality of differentiated and often contradictory interpretations of the *concept* of resilience. Indeed, as David Chandler, the editor of the Journal, *Resilience,* writes in his book, *Resilience* (Chandler 2018), "there is very little consensus on the concept of resilience… Resilience appears to cover a wide spectrum of meanings… this is no coincidence because the concept of resilience has itself been transformed" (Chandler, 2018, p. 5). Transformed, that is, since Holling, Holling, who coined and largely popularized the term resilience, is mentioned precisely once in the entirety of Chandler's text. In the broadest terms, the popular and conventional concept of resilience is increasingly removed from its origins in complex adaptive systems theory, Boolean cellular automata (Levin 1999), and Lotka-Voltaire equations of population dynamics (Holling 1973). Following Delettre (2021), the term has become polysemic. As a result, resilience is difficult to critique because it is unclear to social theorists what exactly is being proposed.

> To the extent that social systems are able to draw on past experience to avoid future disaster, it is important to recognize that such 'learning' is a matter of storing information as practically useful knowledge, rather than of mystically codifying 'wisdom' into the cybernetic structure of social organization. *The proponents of resilience theory are conspicuously unclear about which of these two concepts of societal learning they are advocating*. In building one of three concluding hypotheses on the naively functionalist notion of 'the well-being of social and ecological systems' (p. 21), they demonstrate once again how their vantage- points in fields such as systems ecology have constrained them from seriously engaging the logic of social systems (Hornborg, 2009, p. 254; emphasis mine).

In other words, what is "conspicuously unclear" is where exactly contemporary sustainability systems theorists are promoting a "zero-sum" worldview in which their work constitutes a form of predictive liberal policy science seeking to objectively optimize systems that are, in principle, deterministic and technocratically manageable. Is resilience a normative concept comparable to "health and wellbeing"? Is it a characteristic of social-ecological systems that can, and ought to be, maximized? Does resilience engender a return to the semi-stable, quasi-equilibrium state or whether resilience is synonymous with "adaptive capacity"? Does resilience emphasize regulation or change? Following Olsson et al. (2015), there is a range of "types" of resilience thinking. Although some conform more closely to objectivist functionalism than others, none of them are capable of accommodating core concepts from social and

political theory and all of them promote the idea that resilience – as an expression of complex adaptive systems theory – represents a "unifying concept" for natural and social sciences:

> The incommensurability between the natural and social sciences constrains the dialogue in two ways: the resilience vocabulary does not fit into the social sciences, whereas core concepts and theories in social science—such as agency, conflict, knowledge, and power—are absent from resilience theory… Given its insensitivity to theoretical development of the social sciences and lack of attention to agency, conflict, knowledge, and power, resilience can become a powerful *depoliticizing or naturalizing scientific concept and metaphor when used by political actors… we underline that far-reaching unification as an approach to integrated research can easily result in scientific imperialism (*Olsson et al., 2015, p. 9, emphasis mine).

For Olsson et al., because social-ecological systems theory either disposes of or precludes or renders null core concepts in social theory, it is inherently, unavoidably, antagonistic to those fields. Critically, Olsson et al. recognize that the act of de-politicizing processes relating to coupled human and ecological systems is, in and of itself, a potentially powerful imputation for political action. The fact that resilience theory, regardless of type, attempts to explain social change without reference to the traditional categories of social theory suggests that it is possible to do so without them, and that suggestion precludes the possibility of pluralism between SES theory and environmental justice.

> Rather than try to develop a conspicuously and naively non- political cybernetic etiology of socio-ecological degradation – based on the assumption that such processes, irrespective of capitalist extractivism, are universally patterned, predictable, and potentially manageable – I challenge resilience theorists to address the operation of the global economic system that is the very obvious source of such processes. The attempt to provide an abstract vocabulary for describing SES often cries out for empirical examples that might get the discussion grounded in the real politics of human-environmental relations (Alf Hornborg, as quoted in Peterson, 2009).

Resilience thinkers such as Peterson (2009) strongly reject such assertions by political ecologists and other social theorists:

> Resilience thinking takes a subjective rather than objective view of systems. Being founded in systems theory, it aims to articulate the subjective perspective from which a system is

> analyzed to assist in the mapping and translating between multiple perspectives (Peterson, 2009).

This is a remarkable statement that is directly reminiscent of my prior discussion on Costanza (who also endorsed social-ecological systems thinking, resilience thinking, and complex adaptive systems thinking). Here, the term "systems theory" contracts an almost mystical valence, in no small part, because it is undifferentiated and unattributed to any particular thinker or intellectual lineage within the broader systems tradition. As noted, systems theory is not universally subjectivist. Moreover, one might ask, how is it possible to reconcile the idea of "multiple perspectives" with a theory of change in which social systems are subject to a higher level, cyclical, adaptive process that is agnostic to agency, power and politics?

In many ways, political ecologists are distinctly more familiar with the history and concepts of systems theory than are many contemporary proponents of social-ecological systems theory operating today, and this is undoubtedly because systems theory constituted the catalyst – the "foil" if you will - that first prompted political ecology to coalesce into a unique discipline with its own identity. That is, one must understand systems theory – particularly older expressions of systems theory - in order to understand political ecology. Political ecologists regard themselves as a collective guard against attempts to smuggle structural functionalism into social theory under the guise of "systems." It is, therefore, understandable that political ecologists would be highly -sometimes overly - attentive to facile gestures or perceived threats. However, it is occasionally intoned that political ecologists have a tendency to construct straw-men, or throw the baby out with the bathwater with respect to more circumspect applications of systems concepts. In their preoccupation with opposing functionalism, it is easy to forget *what exactly made functionalism objectionable in the first place* as opposed to the more or less benign aspects of functionalism. Often, the arguments made by early social and political ecologists revealed a less hard-line and more complementarist posture concerning their colleagues in ecological anthropology and cultural ecology. Consider Eric Wolf:

> You try to look at what you see here and what you see there, and what you see at one time and what you see at another, and that is difficult to do without in some sense reifying the relationship at point A and at point B, creating a kind of synchronic model of A and B, and then comparing. But it is necessary to do that. And that, in a peculiar way, that's where we remain functionalists, even though we do not buy functionalism as a total theory, because those sorts of relational models are close to what the functionalists tried to do in looking at

> one set of relations, say West Africa and then East Africa, and comparing them. *Just that one cannot end up with these as eternal verities. It is a step in thinking, and not a result*. The whole thing gets a bit mechanical at this point, and also much too cohesive. But I still think of it as a *very fruitful way to organize one's research*; it's a research strategy that really pays off when you're looking for relationships. It may not be ultimately the explanatory mode that you want, but on the artisan level of how one orders data and thinks about them and looks for connections*, that it is a very useful way of doing things* (Ghani & Wolf, 1987, p. 362, emphasis mine).

Among other things, this demonstrates that political ecology was always aware of, and was never intended to militate against, the types of subjectivist systems approaches that Peterson and others claim to promote. For Wolf, there is the potential for pluralism and complementarism between political theory and systems theory, but that pluralism is contingent on the ontic status of the conceptual objects at play within the systems theory in question, the greatest barrier to pluralism between sustainability science and environmental justice more broadly is the fact that social-ecological systems theory cannot seem to explicitly sort its ontological commitments from its epistemological assumptions and vice versa. When presented as "eternal verities", ontological commitments such as the law of maximum empower or the four-phase adaptive cycle are difficult, although not impossible, to reconcile with a subjectivist epistemology. Accomplishing pluralism, however, will require a more substantial and nuanced effort on the part of social-ecological systems researchers, and the first step in this endeavor will require a more substantial and nuanced understanding of systems theory itself.

3.2: Critical Systems Theory: Complexity and Complementarism

The first thing that both critics and proponents of social-ecological systems theory must understand is that the term, "systems theory," refers to a rich plurality of conceptual themes only loosely bound together into a semi-distinct intellectual tradition. There is, in reality, no lingua franca of systems theory. There are, however, countless texts by numerous authors *claiming* to have distilled the essence of the systems view, and these texts can be sorted into two categories: texts that present one tradition in systems theory as the preeminent tradition to the exclusion of others (Meadows 2008), and; texts that attempt to integrate the various strands of systems theory under a common conceptual theme (Capra and Luisi 2014). A third category would include the throngs of pop science, systems guru, and self-help texts that claim to teach the reader "systems thinking" to "make complexity simple" by "learning the art

of making a great decision" and thinking "like a super thinker." I will ignore such texts, but not without noting two important features of them: first, they have a substantial impact on the popular perception of systems theory, and popular perception undoubtedly influences the academic perception of systems in any number of ways; secondly, they almost exclusively define complexity in the "thin" sense of the term (i.e., "solving" complex problems, "fixing" complex problems, "complexity made simple", and so on). Often, integrationist systems texts teeter precariously on the line between pop science and serious research (Cabrera) and telling the difference between the three categories requires substantial effort and a trained eye. The current, general state of profound confusion surrounding the meaning of systems theories and concepts is, therefore, understandable.

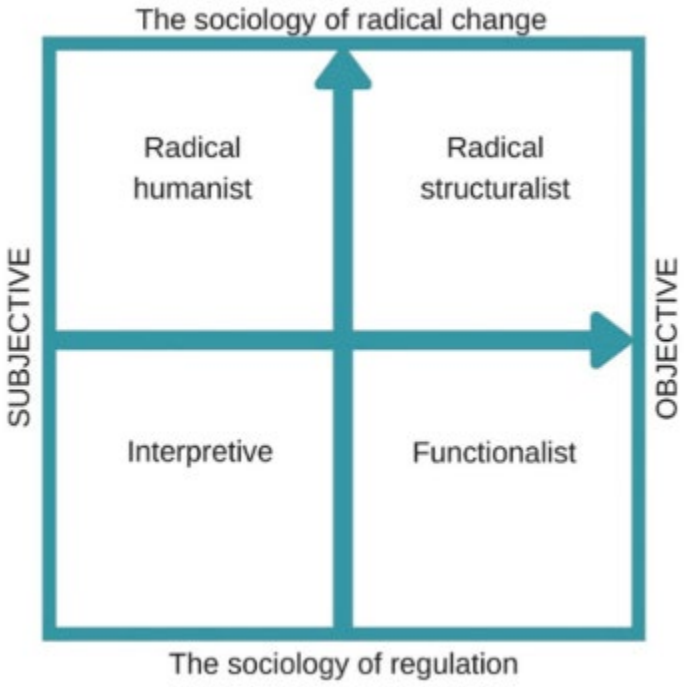

Figure 5: Sociological Paradigms according to Burrell & Morgan (1979).

Critical systems theory arose in the early 1980s with the explicit intention of counter-acting conventionalizing trends in systems discourse by differentiating and categorizing systems theories according to various types. Using the method of paradigm analysis, the critical systems theorists divide the various strands of systems research according to their relative epistemological stance (e.g., subjectivist vs. objectivist) in addition to their social objectives (i.e., radical change vs. regulative status quo) and assign each systems tradition to their corresponding paradigm in social theory (e.g.,

functionalism, radical humanism, radical structuralism, interpretivism, and critical theory; see figure 5)[44]. Using this schema, Odum's formal energy systems language, Hardin's cybernetic ecology, Forrester's system dynamics modelling, and Von Neumann's cellular automata are all examples of *functionalist* systems theory, whereas von Bertalanffy's general system theory and Wiener's first-order cybernetics conform to structuralism[45]. C. West Churchman, in the tradition of Weberian and Husserlian sociology, introduced interpretive systems theory – i.e., Checkland's (1981, 1999) Soft-Systems Methodology (SSM) - and Ulrich, Flood, Jackson, and Midgley, following Habermas, introduced critical systems theory with their critical systems heuristics and the system of systems methodologies (figures 6 and 7). In effect, critical systems theory disposes of the very idea of a unified, monolithic systems genealogy about which any truly general statements can be made. Systems theory, they argued, has never stood apart from prevailing trends in social theory. Rather, following the currents, it has shifted away from consensus-oriented theories toward conflict-oriented theories that emphasize pluralism, equity, and power.

Waves of system traditions (bolded text represents main definitional component).

Systems Tradition	Epistemological Tradition	Status of Systems	Role of Systems Thinker	Emphasis
First wave: Functionalist Systems Theory	**Realist – Objectivist** (Spencer, Parsons, Luhmann)	Systems (boundaries, components, dynamics, etc.) are **ontological commitments.**	Systems thinkers are experts with specialized knowledge of "systems."	**Machine metaphor** stability, regulation, adaptation, optimization
Second wave: Interpretivist Systems Theory	**Interpretive – Subjectivist** (Weber, Husserl)	Systems (boundaries, components, dynamics, etc.) are **epistemological assumptions.**	Systems thinkers help facilitate discussion between stakeholders with different perspectives	**Organic metaphor-** synthesis, deliberation, reconciliation, negotiation, resolution
Third wave: Critical Systems Theory	**Critical - Pragmatist**[a] (Habermas, Peirce, Bhaskar)	Systems (boundaries, components, dynamics, etc.) are **normative claims**	Systems thinkers are facilitators, critics, advocates, activists	**Prison metaphor** power, conflict, emancipation, radical change

Figure 6: Waves of systems traditions. From Kish et al., 2021*. Originally adapted from* Midgley, 2000*.*

Not unlike Wolf's critique of system dynamics, or, indeed, my own position on biophysical economics, contemporary systems theory severely problematizes the all-encompassing ontology of functionalist systems theory whilst acknowledging that the methods of system dynamics and systems ecology are provisionally useful in limited circumstances. Unsurprisingly, functionalist systems researchers, committed to their realist ontologies, have, by and large, removed themselves from the general systems

[44] Like Merchant, critical systems theory problematizes the emphasis on technocratic control, objectivism, and mechanism found in system dynamics. Unlike Merchant, however, CST distinguishes that these are problems in functionalist systems theory specifically and not in systems theory in general. Part of the issue is that Merchant is working with Capra's undifferentiated interpretation of systems theory and his explicit intention to unify the field. Capra, thus, blurs the distinctions made by Strand, Cilliers, and Critical Systems Theorists. Because I embrace these distinctions, I am highly critical of Capra and other conventionalists, unifiers, and popular authors (e.g., Cabrera) whose lack of rigour, in my view, breeds misunderstanding for the sake of marketing an incoherent and problematic systems "brand" divorced of the nuance one finds in primary sources authored by significant figures in systems research.

[45] The consummate structuralist, Levi-Strauss, also explicitly considered Wiener and Bertalanffy to be structuralists.

community and opted to create their own societies[46]. The result was a divide that largely altered the popular perception of systems theory. Whereas the "General System Community" (i.e., the GSC) - coalescing around the Society for General Systems Research (SGSR) - was once a "mothership" for all systems and cybernetics research, it is now primarily comprised of structuralist, interpretive, and critical systems researchers to the relative self-exclusion of functionalist systems research. For example, the presidency of the SGSR (now the International Society for the Systems Science – ISSS) has not been held by a functionalist since Odum in the early 1970s. Functionalists, in turn, created their own international societies and communities, such as the International Society for System Dynamics. It is noteworthy, however, that the ISSD is larger than all other systems societies combined. I contend that this is why system dynamics is often confused for being emblematic of systems research in general[47].

System of systems methodologies.

System of Systems Methodologies Finding the appropriate tool for the problem context		Participants		
		Unitary ("hard" systems theory, functionalist)	**Pluralist** ("soft" systems theory, interpretivist)	**Coercive** (critical systems theory, radical humanist)
Problem Situation	Simple	Simple Unitary (e.g. systems engineering, systems analysis)	Simple pluralist (e.g. *PAR*, strategic assumption surfacing)	Simple Coercive (e.g. critical systems heuristics, boundary critique)
	Complex[a]	Complex Unitary (e.g. system dynamics, classical cybernetics, complex adaptive systems, systems ecology)	Complex Pluralist (e.g. soft systems methodology, group syntegrity)	Complex Coercive (Mixed methods)

Figure 7: System of systems methodologies. From Kish et al., 2021*. Adapted from* Jackson & Keys, 1984*.*

The discourse associated with the contemporary general system community is, therefore, very much in accord with the concerns raised by social and political ecologists – as well as most non-functionalist social theorists - concerning the objectivism and reductionism associated with functionalist systems ontology. With some notable exceptions (Helfgott 2018; Mccarthy 2006; Mccarthy et al. 2011; McCarthy, Tsuji, and Whitelaw 2010), social-ecological systems theory and resilience thinking are unaware of critical systems theory. Indeed, ecological economics has been entirely ignorant[48] of interpretive and critical systems discourse over the last three decades, and this is perhaps why ecological economics is an academic arena in which unambiguously functionalist and social Darwinist arguments can be presented as merely "uncomfortable." There are, of course, many social-ecological

[46] In fairness, System Dynamics researchers have long resisted their being classified as realists and functionalists, and, as is generally the case, this classification depends on individual researchers (See Featherston and Doolan, 2012). Jay Forrester used unambiguously reductionist and objectivist language, but Meadows' epistemology was decidedly more interpretive (see Meadows, 2001).

[47] Merchant, for example, makes specific reference to the Club of Rome and the Limits to Growth study, but she does not account for the decidedly anti-mechanistic penchant present in authors such as, but not limited to, von Bertalanffy, Boulding, or Prigogine.

[48] Prior to Kish 2021, the field of critical systems theory has never before been referenced in the Journal of Ecological Economics.

systems researchers and ecological economists who maintain robust and thorough understandings of the history and concepts of systems theory *without* engaging critical systems theory (I do not mean to suggest CST is the only means of organizing one's understanding of the systems discourse), and I will discuss those thinkers in due course. But the broader point is that social-ecological systems theory is somewhat *removed* from general systems community and was, therefore, absent during significant debates concerning the tensions and possibilities associated with pluralistic systems research.

As my co-authors and I have argued elsewhere (Kish et al. 2021)[49], critical and interpretive systems theory both provide potential means for pluralistic engagement between ecological economics and various other schools of environmental thinking that align with interpretive, critical, and structuralist intellectual paradigms. One of the objectives of the workshops organized by Kish and Mallery (and the subsequent publication) was to bring these distinctions and alternative methods to the attention of ecological economists to replace what Spash has called "uncritical realism" with a more critical, informed, and self-conscious pluralism. This approach also serves as an alternative to the anti-pluralism proposed by Spash, Costanza, and Hall. In accordance with Ulrich's system of system methodologies, the purpose was not only to provide ecological economists with the means of selecting appropriate methodologies according to the problem circumstances at hand but also to aid them in understanding the limitations of the methods they use and how alternative methods might problematize or complement their findings. In many ways, the pluralism debates inaugurated by critical systems theorists within the general system community parallel and, indeed, anticipated the pluralism debate in ecological economics. Critical systems theory proposed addressing (not solving) the issue of pluralism through complementarism: i.e., by disavowing functionalist-objectivist-determinist ontologies whilst respecting the provisional usefulness of functionalist modelling methodologies[50].

Ultimately, however, although I stand behind our contribution to the debate, the limitations of critical systems heuristics for "critical pluralism" are similar to the limitations of critical systems theory itself. Namely, Morgan and Burrell's paradigm analysis (used by Ulrich and many others) is criticized for a) portraying functionalism as the "centrist" standard from which all other social theories deviate and; b)

[49] This text grew out of a series of workshop organized by Katie Kish and me. Note that Melgar-Melgar was an engaged participant in the workshop, and many of the critiques I have outlined herein were aired in our discussions.

[50] The organizing framework for complementarism in critical systems theory is known as "Total Systems Intervention" (TSI; see Flood and Jackson 1991).

excluding post-structuralism as a discrete paradigm in social theory (Deetz, 1996). Indeed, objectively dividing social theories into discrete paradigms speaks to a functionalist orientation in and of itself.

Tsoukas (1993) vociferously denounces the complementarism of critical systems theory, countering that:

> Positivist problem-solving … is not simply useful for achieving technical mastery over social processes. In attempting to do so, it also provides answers to the inextricably interwoven questions of interaction and power. Jackson and Green advise us to play to positivism's (primarily technical) strengths while minimizing its weaknesses. Reality-shaping paradigms, however, are not a la carte menus; you don't just pick whatever suits you at any time. If Jackson, Green, and Midgley believe, as they seem to, that problem-solving methods are not mere instruments but have deep paradigmatic roots, then they must tell us how their complementary use is epistemologically possible (Tsoukas, 1993, p. 313).

In essence, Tsoukas is arguing that the constituent components of one's worldview (i.e., cosmology, ontology, epistemology, methodology, axiology, and praxeology) *must* be consistent throughout for any given researcher, and where it is not consistent, one must assume that the ontological commitments of the researcher conform to those most closely associated with the methodology they are using. Indeed, this is one of the oldest and most familiar critiques levelled against systems theory since the days of Bertlanffy and his General System Theory. Berlinski (1978) sharply dismisses the many threads of systems theory and cybernetics as a collective "sham" due supposedly to the "considerable magnitude… between the subject's aspirations and its achievement", although the true discrepancy his argument addresses is that between the methodology and ontology of systems research. For example, at a single juncture within the multi-step process of the General Systems methodology[51], a differential mode involving ordinary difference equations is employed to search for isomorphic patterns in quantitative data. This quantitative step yielded a more general perception that GST sought the status of a positive, empirical science (despite numerous explicit claims to the contrary) (Boulding 1956; Pouvreau and Drack 2007). From Berlinski:

> Not that there is anything wrong with [differential modes]. A system of differential equations is just the way to represent the interaction of a series of variables; the supreme

[51] The methodology of GST in its entirety involved numerous, and pre-dominantly qualitative, steps beyond differential modelling (see Pouvreau & Drack, 2007).

> example of such interaction systematically treated is classical mechanics. But general systems theory, at least, aims at those principles "that are applicable to 'systems' in general;" without such principles there would be no systems theory. At precisely this point, systems theorists experience an impulse toward prestidigitation. If systems are merely systems of *ordinary differential equations*, the principles that govern them will be parts of mathematics, analysis in particular, the Liapunov stability theorem, for example, or various local theorems concerning the existence and uniqueness of solutions. Yet again, if systems are taken to be merely systems of ordinary differential equations, their principles will be particular empirical laws, the inverse square law and the equation $F = m\frac{dv}{dt}$ in mechanics, or the law of the logistic curve in the theory of biological growth. The italic shift of the preceding sentences is evidence of conflicting and even incompatible intellectual ambitions: if the laws of systems theory are to be general, they cannot be empirical; if they are to be empirical, they cannot be general. Taking the first, we have systems theory coinciding with the theory of ordinary differential equations; taking the second, we ultimately merge systems theory with the various disciplines that use differential equations: mechanics, economics, population theory (Berlinksi, 1978, p. 952).

For Berlinksi, then, the methods we employ are always indicative of a more pervasive, implicit, underlying social ontology that delimits what we view as “real” and why. By contrast, a conventionalist or complemenarist might counter that it is rarely the case that methods – in both the natural sciences and humanities - are entirely in accord with the ontological commitments informing them. Wolf, for example, is perfectly willing to acknowledge the persistent vestiges of functionalism in the conceptual framework of political ecology. Another example from the traditionally positivist natural sciences might be statistical mechanics, which, although it is the most precisely accurate science available for human inquiry, relies on probabilities and does not necessarily support a physicalistic or mechanistic ontology[52].

[52] Consider Kineman (2012, p. 529): “Probability theory occupies a strange place in science, as a grand compromise on the aims of rigid description, and yet as itself an implicit natural formalism. On the one hand, it allows the needed flexibility in the ‘precise’ description of nature, stepping partially away from Newtonian determinism; but it does so without an ontological commitment: probability theory can equally describe our lack of knowledge of a system.”
As a further aside, Berlanffy also acknowledged the affinity between systems theory and the theory of probability: “From the logico-mathematical standpoint, the position of General System Theory is similar to that of the theory of probability, which is purely formal in itself, but can be applied to very different fields, such as theory of heat, biology, practical statistics, and so on” (Bertalanffy, 1952, p. 201).I include this as a further indication that GST was unlike other attempts at the “Unification of Science” (i.e., Carnap’s logical positivism or E.O. Wilson’s consilience)

It may be the case that ontology is a "skin and not a sweater" that cannot be removed (Furlong and Marsh, 2010), but – to turn the metaphor on its head - it is also the case that skin is shed and regenerated, subtly changed, but unmistakeably similar over a lifetime. Indeed, Berlinski's critique is found within what is perhaps the most comprehensive and seminal edited volume in the history systems theory: Klir's (1978) *Applied General Systems Research.* He was *invited* to criticize systems theory by systems theorists themselves, and his convictions even find correspondence with those offered by systems theorists themselves. Consider Rosen:

> A proper understanding of modelling in biology must, I feel, begin with an understanding of the inter-relationships of physics and biology, which are profound and many-faceted. On the one hand, biological organisms are composed of atoms and molecules, and hence they simply are physical systems. The physicist is concerned with understanding the behavior of all assemblages of physical particles, including those that comprise organisms. And it is the fundamental principle of reductionism in biology that we have no real understanding of biological activities unless and until this understanding is expressed directly in terms of the interactions between the physical particles of which the organism is composed, i.e. in terms acceptable and recognizable to the physicist. This view then implicitly denies that there is any useful distinction between the organic and inorganic; between biology and physics.
>
> *A second and rather more subtle relation between physics and biology, which impinges even on holistic and systemic attempts to model biological systems, is that the very machinery of system description, the only tool we possess for this purpose, was developed for the analysis of physical systems (originating in Newtonian mechanics) and that despite extensive generalizations and refinements we still have no other conceptual tools available to describe systems and their behavior than those which proved convenient for physics.*

insofar as Bertalanffy rejected the possibility of a correspondence theory of truth vis-à-vis the triumph of mathematical formalism over metaphysics. By contrast, following Pouvreu and Drack (2010, p. 299-300), Bertanffy's complementarism sought to 'restore the dignity of all "symbolic forms"' (e.g., metaphysics, mysticism, and mythological thought) without subsuming them under an all-encompassing, positivistic science. And, indeed, Bertalanffy strictly warned against the dangers of equating science and metaphysics: "Every model is a conceptual representation of certain traits or formal structures of empirical entities. It leads to intellectual disaster when the model is made into metaphysical reality" (Bertalanffy, 1967, p. 108). Similarly sophisticated, not to mention cautious, epistemological postures are found in Wiener, Bateson, Maturana, Ackoff and many other prominent systems theorists, although they are notably absent in others (e.g., Forrester, Odum, and von Neumann).

> A third relation, which plays a decisive though implicit role in motivating the reductionist viewpoint, is a counterpart of the preceding; namely that the only experimental tools available for the study of biological systems are also of a physical character. We have already mentioned that it is the manner in which we interact with systems which defines their character for us; in experimental biology we are constrained to interact with biological systems by means of techniques and tools invented by the physicist for studying inorganic nature. *This bias on the manner in which we can observe biological systems automatically constrains us to a highly physical view of these systems, selectively emphasizing those aspects of biological systems which our observing procedures, drawn from physics, are geared to detect*. Thus, both the experimental tools with which we observe biological systems, and the conceptual constructs by means of which we attempt to describe them, are both drawn from a non-biological science, not concerned specifically with the complexity and the highly interactive character typical of biological organisms. Therefore, in order to orient ourselves properly with regard to understanding how the modelling of biological systems is to be effectively accomplished, *we must understand more specifically the nature of the biases which our physical tools, both experimental and theoretical, impose on us* (Rosen, 1970, p. 2-3, emphasis mine).

For context, Rosen – who at that point was considered a considerable general system theorist and who served as a reviewer for Berlanffy's seminal 1968 text, *General System Theory* – presented this paper for the Robert Hutchins Institute in San Diego in the late 1970s, and his audience consisted almost exclusively of social theorists with comparatively little prior knowledge of systems theory or, indeed, theoretical science in general. By the phrase "holistic and systemic attempts", Rosen is clearly referring to general system theory and system dynamics (the dominant modes of systems research at the time). By the "tools" of physical systems, Rosen is again referring to differential models of ordinary difference equations and the fact that system dynamics and GST rely on the same mathematics as Newton's dynamical systems. Rosen himself, observing the tension implicit in using the methods of the science that one purports to oppose, restricted his modelling to the abstract mathematics of category theory.

Similar tensions are also explored in Boulding's text, *The Skeleton of Science*, in which he promotes an alternative approach to General Systems Theory[53] that sought to "arrange the empirical fields in a

[53] A potentially interesting editorial note: Boulding referred to General *Systems* Theory (in the plural) whereas Bertalanffy and others referred to GST as General *System* Theory (singular).

hierarchy of complexity of organization of their basic "individual" or unit of behaviour, and to try to develop a level of abstraction appropriate to each" (Boulding, 1956, p. 200). Boulding epistemological hierarchy of sciences is, therefore, not unlike critical systems theory, critical (sans ontology), or post-normal science insofar as it purports that "lower level" technical solutions applied to "higher level" complex problems will inevitably result in disaster. Implicitly, Boulding criticizes Bertalanffy's "isomorphic" approach to General System Theory when he criticizes orthodox economics for its preoccupation with the methods of "equilibrium theory and dynamical mechanisms" applied to quasi-teleological social systems. Elsewhere (Boulding 1977), Boulding also extends this argument to Odum's formal energy systems language[54].

3.3: The Politics of Systems and Cybernetics

By extension, systems theory and contemporary sustainability systems theory appears or is at least received differently depending on the audience. For many, the repeated overtures to "inherent uncertainty" and bounded rationality speaks to a quasi-conservative orientation, questioning the boundaries of reason itself. Often, the operational and methodological answers to the boundaries imposed by uncertainty imply, for many, the opposite – i.e., liberal policy science as technocratic optimism. Cilliers, whom I will discuss at length in later sections, interprets systems theory as analogous, in many ways, to post-structuralism. Sagoff interprets systems theory as a form of neo-medieval scholasticism, fixated on the "balance of nature." None of these interpretations are entirely correct

[54] From Boulding's review of Odum's seminal text, Environment, Power, and Society: "With all these virtues it is a painful duty to have to report that I think the book is profoundly wrong in its overall view of the world, and that while it contains a great deal that is of value, it is seriously in error in its basic position, and if it is believed it could do real damage. The basic error is the failure to recognize that all values are human values created by human valuations. Energy is a limiting factor, a very important one, but only one among many, in restricting the ability of the human race to achieve its values and desires, but energy neither creates value nor measures it. An energy theory of value indeed underlies a lot of the theory of this book even though it is never directly stated. It is even more fallacious than the labor theory of value, which has caused much human misery. Social systems cannot be reduced to physical description whether in terms of energy, entropy or any kind of physical or engineering efficiency concepts… Energy is likely to be a dominant human problem in the next hundred, or perhaps thousand, years. It is a limiting factor in all processes of production, whether that of the chicken from the egg or a house from a blueprint. A limiting factor, however, not a causative factor. Evolution, both biological and social, is essentially a process in information, knowledge or know-how, which may be limited by lack of energy and materials but is not created by their presence…The Odums are ecologists and ecologists, like many economists, have been obsessed by equilibrium. The real world, however, is an evolutionary, that is, disequilibrium, system, and crude equilibrium models of energy flows are only a first step towards understanding it" (Boulding 1977). Note that Boulding extended a similar critique to Georgescu-Roegen's *The Entropy Law and the Economic Process*. Ultimately, however, Boulding's concerns of NGR proved unwarranted and misdirected. Georgescu-Roegen proposed no such energy theory of value, and he opposed social determinism in principle for reasons similar to Boulding's.

because, once again, systems theory is extensively heterogeneous, and the ideological orientations implied by systems theory are as diverse as systems theory itself. This was also true for the "precursor" discourses to systems theory, such as holism and organicism, and attempts to shunt systems discourse into any particular ideological tradition invariably rely on highly selective comparisons and historical parallels.

In reality, the concept of holist organicism itself, similar to evolutionism, was ideologically agnostic, but different expressions of organicism, based on often highly nuanced differences, explicitly lend themselves to specific ideological and political imputations. Following Foucault, life itself, like human nature, serves as "an epistemological indicator to designate certain types of discourse in relation to or in opposition to theology or biology or history" (Chomsky & Foucault, 2001 [1971], p. 7). All of the major geopolitical ideologies of the 20th century claimed organicism to lend scientific credence to their respective political imputations and propagandistic weight to their claims of inevitable dominance over their rivals.

American liberals and capitalists like Rockefeller embraced Spencer's social organicism and progressive evolutionism to justify the colonial expansion of manifest destiny and the inequality of the American industrial gilded age. Rather than rejecting Spencer (as Marx did), American second internationalist Marxists embraced Spencer and claimed his synthetic philosophy was analogous to Historical Materialism (Pittenger 1987). Spencer himself was an ardent liberal, anti-communitarian, but he was also an outspoken anti-colonialist and advocate for the Indian Independence Movement. Pareto, whom Popper famously called "Mussolini's economist" for his support of Italian fascism at the end of his life, also promoted Spencer's functionalist sociology and progressive evolutionism. Spencer's assistant, Arthur Tansley, shared in Spencer's anti-communitarianism and partially invented the concept of the eco-system as a materialist counter to the vitalist-organicism of socialist-communitarian (Hagen 1992). American naturalists such as Frederick Clements. Clements' concept of the vegetative community was, in turn, inspired by the holist philosophy of Jan Christian Smuts, the philosopher, former Boer general, long-standing Prime Minister and founding father of South African statehood.

From these original associations between organicist philosophies and political ideologies, many new, sometimes unintuitive or downright paradoxical connections have been drawn over the past century. The eventual endpoint of the Spencer genealogy was Odum, who, against both his mentor Tansley and Tansley's mentor in Spencer, embraced Marxism. Not unlike the second internationalists a half-century before him, Odum viewed socialism as optimally efficient and, therefore, inevitable as a form of social

organization that would outcompete the others. As a result, contemporary eco-Marxists such as Foster and Burkett valorize Odum and Tansley as "material holists" whose material concept of the ecosystem served as a "direct refutation" to the allegedly "teleological," 'proto-apartheid, idealist "holism" of Smuts' (Foster & Burkett, 2016, p. 49). In making this claim, Foster and Burkett attempt to establish a sort of moral symmetry underlying holistic philosophy: idealist holism (including Smuts and Spencer) is racist and wrong, whereas material holists (such as Marx and Odum) are not. Material holism supposedly lends itself to equitable communitarianism, and idealist holism supposedly lends itself to racism and authoritarianism. However, Foster and Burkett overlook some key historical points in making these claims.

Neither Spencer nor Smuts were idealists, and both were explicitly critical of any approach that affirmed teleology or final cause (Haines 2017)[55]. Spencer was the original "material holist" and those that came after him, such as Tansley and Odum, share in his legacy of eugenics and social Darwinism[56]. Smuts, by contrast, belonged to the tradition of British emergentism, an often-overlooked genealogy that opposed idealism and materialism in equal measure. Indeed, for emergentists, the claim was not only that idealism and materialism were not equally scientifically inadequate, they were part of the same mechanistic paradigm. They were, therefore, "limited by the same images and metaphors" (Haraway,

[55] From Smuts (1926, p. 338): "It is said that Evolution discloses a grand inner Purpose, that Nature or the universe is purposive or teleological, and that no other category will do justice to the great fact of Evolution as we see it. But if there is purpose there must be a Mind behind that purpose. And thus Mind comes to be personified in Nature as the source of the great evolutionary purpose which the world discloses. Cosmic Teleology spells a corresponding transcendent Personality. Do the facts warrant or necessitate such tremendous assumptions? *Would it not rather seem that the whole basis of this reasoning is unsound and mere speculation?* In all the previous cases of wholes we have nowhere been able to argue from the parts to the whole. Compared to its parts, the whole constituted by them. is something quite different, something creatively new, as we have seen. Creative Evolution synthesises from the parts a new entity not only different from them but quite transcending them. That is the essence of a whole" (emphasis mine).

[56] Further note that Odum's father, Howard W. Odum, was an eminent functionalist sociologist (made President of the American Sociological Association in 1930) whose studies on the "folkways of southern blacks" promoted both segregationist and paternalistically racist views (see Silcox, 1977). According to Silcox, Howard W., discussing black students in Philadelphia in early 20th century, noted, "In … tests ranging from the simplest to more complex the Negro children tend to decrease in efficiency as the complexity of the process increases, as compared to white children" and he insisted this was proof of "the existence of fundamental differences between white and Negro children." He further insisted that black students' "lack of adaptation" costed taxpayers, and so argued that education for black children should be limited to remedial or vocational training in separate schools. Following Silcox, Odum's arguments "would become the basis for upholding segregated schools in Philadelphia" until it was abolished. The reader will notice that Odum's arguments bear conceptual hallmarks of both functionalist and contemporary systems ecology (e.g., complexity and adaptation). Both Howard T. and his brother, Eugene, Odum cited their father as an enduring influence on their own work.

1976, p. 38). Smuts, for example, places the blame for mechanistic determinism (which he rejects) squarely on *Hegel:*

> If the original creation were complete and absolute, all subsequent events and changes can only be rearrangements, reshufflings of the original groupings: both the material elements and their principals or forms of arrangement are there as original data, and' determine all subsequent events and arrangements. If, again, the metaphysical scheme or structure of the world must be taken as given, its evolution is merely a logical development in compliance with this scheme; or in other words, the logical development of the scheme will give us the material world as a result. The development of Hegel's Idea is just such an attempt at a logical unfolding of the world. In both cases the explanation of the world is in the past, at the beginning: that beginning governs all and predetermines all. The past is the efficient cause of the future, and no new creation, nothing essentially new, can arise in the future. The full volume of reality was there at the beginning and continues to roll on changing its forms and appearances by the way, but making no fresh addition to the original current. All real novelty and initiative, all real freedom of choice and development disappear from the world. The process of the world becomes at most an explication, an unfolding of what was implicitly given, and not a creative evolution of new forms. This view-point has been dominant in Western science and philosophy from its early beginnings until quite recently (Smuts, 1926, p. 87).

In attempting to re-contextualize both Smuts and Spencer, I neither seek to redeem or place further blame on either of them, but rather, I am simply trying to dispel the illusion of tidy moral symmetry in the history of holism that Foster and Burkett are attempting to promote. The history of holism is distinctly messy; Spencer was not problematic because he was an idealist (which he wasn't), nor was he problematic because he was a materialist (which he was); he was problematic because he used materialism to promote problematic ideas. Politically, Spencer and Odum, like Rockerfeller and the Second Internationalists, applied the same theoretical concept (i.e., the Universal Principle of Evolution equivalent to the Law of Maximum Empower) to promote opposing schemes for social organization (liberal democracy versus communitarianism). Smuts, on the other hand, was problematic despite rejecting both idealism and materialism, but that made him distinctly unique among other British

Emergentists who generally espoused a more progressive worldview[57]. As Haraway notes, a "second" genealogy of British emergentism parallel to that of Smuts was distinctly socialist, including British organicists such as Joseph Needham and C.H. Waddington. Needham was a contemporary of Bertalanffy and a rabid anti-reductionist. He founded UNESCO with Julian Huxley and was famous for his extensive scientific diplomacy with the Republic of China. As a result, he was also blacklisted in the United States until the 1970s for his alleged socialist sympathies.

In Germany, Jakob von Uexkull's vitalist organicism was embraced as "Aryan science", whereas the Nazis associated "profane materialism" with lesser, degenerate peoples. Indeed, the Nazi SS maintained an extensive medical core that committed grievous acts of genocide whilst concurrently offering public nutrition programs and mobile cancer screening services. The administration of public health and the wholesale murder of "degenerates" were considered under Nazism as equally curative acts, necessary in attending to the health of the collective body of the German 'volk". Following Gilbert and Sarkar, "The Jews, they said, were materialists who could not see the wonders of Nature and who were bent on reducing thought, beauty, and love to mechanical terms" (p. 4). Conversely, the German embryologist Hans Driesch's vitalist organicism concurred with that of von Uexkull, but he lost his academic appointment due to his outspoken support of his Jewish colleagues. Von Bertlanffy, whose General System Theory drew from both Driech and von Uexkull, joined the Nazi Party in 1938 and wrote precisely one article aligning his organicism with "Aryan science". In the aftermath of the war, Bertlanffy recanted his earlier support for National Socialism before a denazification committee at the University of Vienna, claiming that he had only done so under duress and as part of an attempt to hide his Jewish ancestry (this was a lie). Ultimately, he was exonerated, and the committee determined that although he had acted immorally and opportunistically, he was not, in fact, a Nazi (see Pouvreau, 2009).

After his contributions to Allied air defence during the second world war, Norbert Wiener attempted to have his research systematically removed from military application. Conversely, Jon von Neumann, informed by his game theory, famously championed the unilateral and pre-emptive nuclear annihilation of the Soviet Union in the aftermath of World War II[58]. Kenneth Boulding, by contrast, was a peace

[57] Although it should be noted that Smuts, for his time, and despite the fact that he was among the first to advocate for apartheid (another term that he coined), was considered a consummate progressive internationalist stateman on par with Woodrow Wilson, whose League of Nations Smuts strongly supported at the Paris 1919 peace conference.

[58] Von Neumann famously quipped: "With the Russians it is not a question of whether but of when… If you say why not bomb them tomorrow, I say why not today? If you say today at 5 o'clock, I say why not one o'clock?" (Roberts 1998).

activist, an anti-fascist, an activist for nuclear disarmament, and a communitarian in the tradition of Quaker social activism. He was also an outspoken critic of Marxism, which he dubbed a "secular religion" in the Abrahamic tradition. Conversely, Stafford Beer's cybernetic "Viable System Model" was embraced by Salvador Allende, the popular Marxist democratic President of Chile, who, with Beer's consultation, applied the VSM to the centralized planning of Chile's economy from 1971 to 1973. Dubbed "Cybersyn," the project ended abruptly with Allende's assassination during a CIA-coordinated coup d'état that would bring Augusto Pinochet to power.

What this section is simply meant to demonstrate is that for every example in which systems, or cybernetics, emergentism, or holism, are associated with authoritarianism, or Marxism, or liberalism, or whatever else, there is a counterexample of the same or similar ideas being used to support a contrary ideological position. What this tells us is that ideology is often promiscuous; it will attach itself to whichever concepts it must integrate to claim validation, even if it means distorting the ideas it is seeking to uphold. This should also indicate to us the exceptional power of holistic thinking throughout the twentieth century, such that no ideology could have legitimacy without also claiming concepts of holism, emergence, self-organization and evolution that upheld it. As we shall see, this situation remains true today.

3.4: A genealogy of genealogies of Resilience

Turning now to more contemporary systems theory, we see there is similarly minimal necessary affinity between systems concepts and the political imputations they are used to promote. Some recent scholarship insists that resilience theory represents an implicitly neoliberal philosophy that is "perfectly in accord" with the philosophy Austrian economic theory of Hayek[59] (Grove 2018; Walker 2020; Walker and Cooper 2011). For Walker and Cooper, the claim that resilience is inherently neoliberal is supported, on the one hand, by the popularity of the resilience concept amongst financial economists:

> Since the 1990s, global financial institutions such as the International Monetary Fund (Nsouli et al., 1995; International Monetary Fund, 2005), the World Bank (2006) and the Bank for International Settlements (2002, 2008) have increasingly incorporated strategies

[59] From Walker and Cooper (2011): "While the redefinition of the concept can be directly traced to the work of the ecologist Crawford S. Holling, the deployment of complex systems theory is perfectly in accord with the later philosophy of the Austrian neoliberal Friedrich Hayek. This ambivalence is reflected in the trajectory of complex systems theory itself, from critique to methodology of power" (p. 143).

> of ‘resilience’ into their logistics of crisis management, financial (de)regulation and development economics (Walker and Cooper 2011).
>
> The success of this ecological concept in colonizing multiple arenas of governance can be attributed to its intuitive ideological fit with a neoliberal philosophy of complex adaptive systems, the under-acknowledged legacy of Friedrich Hayek. Where once it was commonly assumed that neoliberalism was of a piece with the neoclassical method of the Chicago school, this crudely positivist current of neoliberalism has increasingly been overtaken in intellectual influence by the mature Austrian philosophy of Hayek. Further, it would appear that the science of complex adaptive systems has become a discursive reference point for the full spectrum of contemporary risk interventions. Whereas energy physics provided a foundational role in modernist theories of economic and ecological organization, and the homeostatic systems of first-order cybernetics dominated the economic and military sciences of the Cold War, complexity science now serves as a source of naturalizing metaphors for contemporary practices of security, functioning to neutralize critical inquiry into the disastrous consequences of neoliberal policy in the arenas of financial regulation, urban planning and crisis response, development, environmental management, and climate change (Walker & Cooper, 2011, p. 144).

Although the concept of resilience has indeed been co-opted to support capitalistic, militaristic, and generally “regulative” functionalist interpretations, these are, I argue, typically the result of pervasive misunderstandings regarding the nature of Holling’s theory. Namely, as political ecologists point out, the majority of Resilience research is predicated on the assumption that resilience is a normative concept, and the notion that resilience research is an inherently functionalist concept of social regulation relies on the assumption that resilience is a variable to be optimized. This is, I agree, a significant problem for contemporary “resilience thinking”, but it is not a problem that stems from Holling’s theory itself, as he provided numerous caveats against interpreting resilience as normative.

A key example lies in the many researchers who misinterpret Holling’s original 1973 article that first introduced the version of social-ecological resilience used by systems ecologists (note that alternate, largely forgotten concepts of resilience were present in the literature before 1973). Chandler recounts Holling’s article as follows: “In 1973 Holling published a much-cited paper on resilience and the stability of eco- systems, articulating system resilience in distinction to ‘stability’ understandings of return to equilibrium after an external shock or disturbance.” This account is subtly inaccurate. Holling did not

only “distinguish” between resilience and stability, he *defined* resilience and stability *in terms of one another as inverse variables.*

> One can be termed stability, which represents the ability of a system to return to an equilibrium state after a temporary disturbance; the more rapidly it returns and the less it fluctuates, the more stable it would be. But there is another property, termed resilience, that is a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables. In this sense, the budworm forest *community is highly unstable and it is because of this instability that it has an enormous resilience* (Holling, 1973, p. 15).

The implications of the relationship between stability and resilience are ignored in both normative and critical interpretations of Holling’s theory. For Holling, a system cannot be both resilient and stable concurrently. A system is resilient *because* it is unstable and vice-versa. This implies that the pursuit of resilience as a positive end in and of itself is mistaken; resilience comes at the *cost* of stability, and stability is, quite obviously, generally considered a desirable quality in social and economic systems. Another misconception stems from the interpretation of socio-ecological resilience as synonymous with “adaptive capacity,” and this is, once again, mistaken. For Holling, resilience is “the magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behaviour” (Gunderson & Holling, 2002, p. 28). Holling points to the Soviet Union as an example of a highly resilient “dictatorship of the bureaucracy”:

> Its very resilience preserved a maladaptive system. What this suggests for social systems, as well as ecological ones, is that resilience is not an ideal in itself. Moreover, it is not a fixed quantity that defines a system, but a dynamically varying one. Resilience can be the enemy of adaptive change. That is, the myth of Nature Resilient is too partial and static in a structural sense.
>
> But what do we do? What is enduring and must always be so? What is sustainable? We need a transition from the structurally static view of Nature Resilient to a structurally dynamic view of Nature Evolving (Gunderson & Holling, 2002, p. 32).

The idea that resilience theory is “perfectly in accord” with neoliberal philosophy strikes me as an unfortunate case of reading between the lines, but only at the expense of what is clearly being stated. Resilience theory has at least two explicit connections to Austrian economists through Jon von Neumann

(who developed the methodology of Boolean cellular automata employed in complex adaptive systems research) and through Joseph Schumpeter, whose concept of "creative destruction" served as a key inspiration for Holling's theory of Panarchy[60]. Although it is true that von Neumann's game theory had a profound influence on orthodox economic theory throughout the twentieth century (see Mirowski, 2002), this fact in and of itself should not suggest that there is anything implicitly neo-liberal about complex adaptive systems researchers. In particular, Schumpeter's theory of "creative destruction", invoked repeatedly by Holling, describes what Schumpeter viewed as the inevitable collapse of free market capitalism and its replacement with socialism. This puts Holling's critique of the "pathology of resource management" and the economization of nature into perspective, challenging any claim that there exists a correspondence between the relational ontology of resilience and the optimization ontology of contemporary economics. In the logic of Holling's adaptive cycle (i.e., Panarchy), it is precisely those systems that are *most* efficient – due to high interconnectivity and low functional diversity - that are also the most "ir-resilient"; i.e., vulnerable to collapse from comparatively minor perturbations. Conversely, by cautioning that resilience can also result in the pernicious persistence of maladaptive systems, Holling clearly telegraphs that the concept is *meant* to be descriptive rather than normative[61]. In many respects, Panarchy is the *opposite* of social Darwinism, or historicism, or even Hegelian idealism, because there is no fixed, shining point on the horizon that social and ecological systems are inevitably pulled towards.

In truth, the concept of "spontaneous order" far predates Hayek in economic theory, and, indeed, practically all economic thinking is predicated on one or another version of the notion that economies are both self-organizing and self-regulating. Even beyond the strict boundaries of classical and neoclassical economic theory, one finds that various concepts of self-organization, self-regulation, and feedback control are abundant throughout history. Mayr points to the Oil Lamp of Philon of Byzantium or the ancient float-valve registers such as the Banu Musa of Baghdad. Needham, a scientific ambassador to the People's Republic of China, pointed to the south-pointing chariot (a mechanical compass invented in the Han dynasty) as the first historical example of cybernetics. Others point to Chang Tsu as the earliest progenitor of the concept of self-regulation. Mayr (1970) provides countless

[60] To clarify, although I note that Schumpeter was an Austrian as well as an economist, I am aware his theories did not conform to the heterodox school of Austrian Economics in the tradition of Ludwig von Mises. Both Jon von Neumann and Friedrich Hayek studied under von Mises, and both promote differential interpretations of spontaneous organization and order.

[61] I emphasis "meant" in this statement because I am aware that the majority of publications on resilience adopt a normative interpretation (see Olsson et al., 2015).

other examples: William Henry's sentinel register; the safety valve of Papin; self-regulating windmill sails; James Watts centrifugal governor, and; Maxwell's seminal paper *On Governors*.

According to Richardson, spontaneous order, self-regulation, and feedback control concepts were "part of the spirit" of the Enlightenment. For Adam Ferguson, society is the "result of human action, but not the execution of any human design." For both Karl and Michael Polanyi, the invention of the concept of spontaneous order in Western thought demarcated the rejection of teleology, neo-Aristotileanism, and scholasticism and their replacement with the "discovery of society"; the idea that society creates itself apart from the control of God. Although I am critical of John Bellamy Foster at various points in this text, I strongly concur with his historical claim that Marx's theory of the "metabolic rift" – the idea that urbanities rely on resource flows and sink capacity from their hinterlands - was indeed grounded in the newfound enthusiasm around thermodynamics and energetics, reminiscent of later open systems theory and self-organization. Smith, by contrast, did not seek to argue that the economic process was "naturalistic" as, for example, the physiocrats had before him; rather, economic systems, insofar as they were subsets of social systems, reflected the "nature" of societies alone (K. Polanyi, 1944). Furthermore, although Smith's theories are predicated on an invisible hand that is collectively propelled by individual self-interest, it is important to remember that Smith himself did not subscribe to the conservative notion that humans are "naturally" self-interested (i.e., homo-economicus). Rather, Smith, a rational humanist, stressed that the remarkably self-regulating capacity of the market was predicated on a pre-existing structure of rationally established rules governing private property and exchange (K. Polanyi, 1944). Following Hayles (1999), Wiener's cybernetics was intended to extend this tradition rather than displace it[62].

For economic conservatives, then, it was indeed necessary to naturalize self-interest in order to counter the rationalism of classical economics and to integrate the concept of the free and self-regulating market as a mechanism for the "natural tendency" of a highly stratified society. In fairness to Walker and Cooper, Hayek did indeed pursue systems and cybernetics as a naturalistic foundation for his neoliberal philosophy, and I agree that fact is important for political ecologists to address (see Chapter 5

[62] From Hayles (1999, p. 7): "Wiener did not intend to dismantle the liberal humanist subject. He was less interested in seeing humans as machines than he was in fashioning human and machine alike in the image of an autonomous, self-directed individual. In aligning cybernetics with liberal humanism, he was following a strain of thought that, since the Enlightenment, had argued that human beings could be trusted with freedom because they and the social structures they devised operated as self-regulating mechanisms. For Wiener, cybernetics was a means to extend liberal humanism, not subvert it. The point was less to show that man was a machine than to demonstrate that a ma- chine could function like a man.

of this text). Hayek makes references to cybernetics, open systems theory, and general systems theory, but he never acknowledges von Bertalanffy's antipathy toward cybernetics over its concerning pre-occupation with "control," nor does he acknowledge Wiener's explicit warning against the application of cybernetics in economic theory. Hayek admitted to having a decidedly casual understanding of most expressions of systems theory and cybernetics[63], and, like most novitiates in the discourse, he fails to appreciate the differences between the various theories. Hayek makes many references to the classical cybernetics of Wiener, but it is important to recall that 1) von Bertalnffy was deeply distrustful of cybernetics due to its preoccupation with "control" and; b) Wiener was deeply critical of any suggestion that his cybernetics should be applied to economic theory.

> The mathematics that the social scientists employ and the mathematical physics that they use as their model are the mathematics and the mathematical physics of 1850. An econometrician will develop an elaborate and ingenious theory of demand and supply, inventories and unemployment, and the like, with a relative or total indifference to the methods by which these elusive quantities are observed or measured. Their quantitative theories are treated with the unquestioning respect with which the physicists of a less sophisticated age treated the concepts of the Newtonian physics. Very few econometricians are aware that if they are to imitate the procedure of modem physics and not its mere appearances, a mathematical economics must begin with a critical account of these quantitative notions and the means adopted for collecting and measuring them (Wiener 1966, p. 90) [64].
>
> … Thus the economic game is a game where the rules are subject to important revisions, say, every ten years, and bears an uncomfortable resemblance to the Queens croquet game in A lice in Wonderland, which I have already mentioned. Under the circumstances, it is

[63] From Hayek (1988): "When I began my work, I felt that I was nearly alone in working on the evolutionary formation of such highly complex self-maintaining orders. Meanwhile, researches on this kind of problem — under various names, such as autopoiesis, cybernetics, homeostasis, spontaneous order, self-organisation, synergetics, systems theory, and so on — have become so numerous that I have been able to study closely no more than a few of them."

[64] Whenever this passage is quoted, the text begins where I have begun it here. But I feel it is my duty to point out that the pre-ceding text reveals a deeply problematic sentiment on Wiener's part. Wiener, in short, is comparing economists to "primitive" Africans who, he argues, believe that they have achieved "modern society" by adopting the dress and parliamentary procedures of Europeans. This is, quite obviously, the most Eurocentric, paternalistic, and, frankly, racist way possible to make the important argument that economists believe, by having adopted the signifiers of science, that they have achieved their status as arbiters of objective truth. I affirm this point, but I reject the racist analogy used to make it. Georgescu-Roegen, Boulding, and Mirowski make similar arguments.

> hopeless to give too precise a measurement to the quantities occurring in it. To assign what purports to be precise values to such essentially vague quantities is neither useful nor honest, and any pretense of applying precise formulae to these loosely defined quantities is a sham and a waste of time (p. 91).

What both Walker and Cooper overlook is exactly what Hayek himself overlooked: the fact that different systems and cybernetic theories, despite superficial similarities, are neither interchangeable or necessarily consistent. The field of Complex adaptive systems is not cybernetics, and neither is consistent with general system theory (neither theoretically, philosophically, nor methodologically)[65]. These were competing paradigms, not complementary ones (see Chapter 5, this text). Furthermore, complex adaptive systems did not exist at the time that Hayek was writing except in the protyle of von Neumann's theory of cellular automata. Although Hayek and von Neumann were intimately familiar with one another's research by virtue of sharing an epistemological community in Austrian economics, Hayek did not follow von Neumann nor did he employ von Neumann's methods (likewise, von Mises explicitly rejected cellular automata in a rebuke of his former student, and von Neumann's co-author, Oskar Morgenstern).

The fact that neo-liberal economists today have co-opted resilience is an expression of a much longer history of conservative and economic theorists turning to the natural sciences for "naturalizing metaphors." By the same token, ecology frequently looks to economics for technical and methodological tools (e.g., system dynamics of cellular automata)[66]. But this should not suggest that theories of self-organization are any more interchangeable than theories of political economy. If Holling's theory was explicitly inspired by Schumpeter and operationalized by a methodology first developed by von Neumann and later adapted by the likes of Levins and Gell-Mann, then why implicate Hayek? Why not point out that contemporary neoliberals must first misinterpret resilience theory in order to then objectify and operationalize the concept to their own ends? Ultimately, the suggestion of correspondence between Holling and Hayek is a red-herring and one that obscures the very tangible correspondences between both Hayek and Hardin and Resilience thinking with von Neumann.

This intervention is not intended as a defence of complex adaptive systems or resilience thinking, as I myself am critical of both. What I mean to point out is that it is necessary for anti-humanists to

[65] Indeed, Von Bertanlanffy was resentful of cyberneticians' success in popularizing the concept feedback
[66] Natural scientists also took theoretical inspiration from political economy; both Darwin and Spencer, for example, cited Malthus as an important source of inspiration.

conventionalize, and thereby objectify, systems and cybernetics in order to co-opt them. They employ superficial readings across a broad spectrum of theories because a deeper excurse in any one orientation would reveal inconsistencies. I critique the critics because I contest that by accepting and adopting similarly conventionalized and generalized interpretations, they inadvertently reify the anti-humanist claims that hegemons are entitled to these ideas when they are not. We ought not to tilt at windmills when there are real giants that need slaying. And we ought not to arm them with the conceptual tools they desire.

3.5: From Economism to Ecological Political Economy

This rapid-fire excurse through the political history of organicism, holism, and systems theory demonstrates that systems themes can variously act as Rorschach tests that reveal implicit political and ideological commitments among the researchers and theorists who pursue such ideas. That is, the ideas themselves do not intrinsically lend themselves to liberalism, communitarianism, or authoritarianism, despite the fact that they have lent themselves to all three at one point or another, often simultaneously[67]. There are no categorical linkages between systems theory and specific political or economic philosophies to be discerned here. The history of the proto-systems discourses (i.e., organicism, holism, and British emergentism) is characterized by theorists struggling to overcome the dualisms associated with vitalism-reductionism and idealism-materialism. As a result, concepts from the organicist genealogy do not map comfortably atop contemporary democratic political theory – dominated by debate between liberals and communitarians – because a) many organicists were attempting to transcend the very epistemological categories that dominant modern political paradigms

[67] This is somewhat akin to long-standing debates relating to, for example, Nietzsche or Marx, and whether their respective philosophies are inherently implicated in the crimes against humanity that were perpetrated in their names. To be clear, I reject these claims for the same reason that I reject generalized interpretations of systems and cybernetics. Following radical democrats, I view "post-Marxist" thinking as dissimilar from "anti-Marxism" and I also adopt their post-structural interpretation of Nietzsche. Although I am similarly critical of historical materialism as an expression of social determinism and economism, I view the Marxian concept of alienation as an indispensable critique of capitalism and modernity. It also must be said that Marxism, like systems and cybernetics, is extensively heterogenous. Ultimately, class analysis, like functional analysis, is an essential perspective for social theory, so long as social theorists are vigilant against class-reductionism or functional-ism - since both extremes are anti-humanist insofar as they eradicate agency. In the case of Nietzsche, I contend that immeasurable harm has been done by critics who have chosen to interpret him as a systematic philosopher (ignoring his explicit rejection of systematic philosophy). To that end, although I perceive the post-structural (e.g., mainly Foucauldian or Deleuzian) interpretation of Nietzchean perspectivism as opposing, in many important respects, Nietzche's radical-aristocratism, I contend that it is more valid and essentially Nietzschean than the "systematic" interpretation shared by Nietzsche's critics and fascistic proponents. Following Connolly, I contend that the "true" Nietzche is less interesting than what can be done - once appropriate caveats and cautions have been put in place - with many of his ideas.

rely on, and; b) the ideas can either be re-purposed, or simply misconstrued, to serve different, and sometimes violent, political ends. As we have seen, in the modern discourse on the politics of the environment, systems theory and its related concepts (e.g., complexity) have been conventionalized to the extent that the political implications attached to particular theorists' use of specific concepts have been obscured.

This, in my view, constitutes a significant problem for several reasons. First, within the sustainability discourse, systems theory is frequently presented as an instrument of "third-way" politics beyond not only the communitarian-liberal debate but also beyond the right-left spectrum altogether. Costanza and Hall's arguments are examples in which systems theory has become an objectivist imputation for shutting down contestation and superseding politics altogether. The authors, it must be said, are well-intentioned in both cases. Costanza does not see the inherent contradiction involved in promoting the idea that systems theory engenders "multiple perspectives" whilst simultaneously promoting an alternate-and-incommensurable interpretation of systems theory as environmental determinism. His concern is in addressing and excluding climate denialism, and by asserting that the acceptance of his deterministic interpretation of systems ecology is (or should be) a precondition for participation in ecological economic discourse, he is also inadvertently calling for the exclusion of those who do not deny climate change, but who do deny environmental determinism. Critical perspectives are, therefore, dismissed in the name of excluding reactionary extremism. Likewise, Melgar-Melgar and Hall's good intention is to address the inability of neoclassical economic theory to consider even the possibility of biophysical constraints because neoclassical economics wrong-mindedly considers nature itself as subject to the rules of the economic process. Melgar-Melgar and Hall demand that environmental theorists must acknowledge environmental determinism and social Darwinism (i.e., Odum's maximum empower) as "immutable fact" so as to counter the irrationality of neoclassicism. In effect, they mean to replace neoclassical economism with biophysical economism. Although they do not specify what sort of policy agenda maximum empower engenders, they nonetheless insist that biophysical economics should hold a privileged epistemological position in determining the trajectory of environmental policy science (over and above, for example, environmental social theory and the humanities). For Odum himself, maximum empower represented an objective, functionalist imputation for communism. Modern eco-Marxists who embrace Odum then conspicuously tiptoe around his relationship to structural functionalism, social determinism, technocratic optimism, and environmental determinism, and they justify this on the basis of critical realism. Spash, in promoting standardization around critical realism, ignores the privilege he is granting to theorists such as Hall and Foster at the expense of critical voices.

The recurring problem is that each of these theorists, in attempting to privilege their own positions in opposition to the dominant, hegemonic paradigm, inadvertently creates affordances - in the forms of social Darwinism and environmental determinism - for different and equally pernicious forms of authoritarianism.

The pluralism debate in ecological economics is a microcosm of the broader debate on the politics of sustainability, and it reflects a pervasive perception that the sustainability crisis is the result of an inability to form a consensus due to relations of political antagonism between decision-makers. In three of the four examples provided (i.e., Spash, Costanza, and Hall), the prescriptions to address this antagonism and decision-making gridlock represent differing expressions on the same essential theme: the exclusion of invalid perspectives and the affirmation of a select set of privileged perspectives. Only the political victory of "correct" technocratic perspectives and the marginalization of the wrong will suffice. Politics itself is an obstacle, rather than the means, to averting disaster. These positions militate against all-inclusive pluralism (i.e., Norgaard) on the grounds that it creates affordances for the infiltration of hegemonic technocracy. The uneasy relationship between political ecology and ecological economics is, accordingly, evocative of that between sustainability science and environmental justice. EJ cannot abide by a consensus that privileges technocratic optimism and places biophysical ontology prior to social ontology, nor can it abide by "uncritical" pluralism that platforms hegemonic voices above critical, unorthodox perspectives. Pluralism that is predicated on the hope for future consensus is not pluralism; it always arbitrarily excludes ways of being, seeing and knowing that threaten to legitimately contest the consensus.

What is the alternative? There is one approach that has not been widely considered, and that is the affirmation of antagonism in its sublimated form: *agonism*. Agonistic pluralism is a concept that is championed by the radical democratic tradition in political theory (Honig 1993; Mouffe 2013; Schoolman 2002), and this idea has been effectively transferred to the environmental politics discourse by Machin (Machin 2013, 2014b, 2020; Machin and Ruser 2021). Here, I will 1) briefly introduce the radical democratic tradition and the concept of agonistic pluralism; 2) discuss Machin's application of Mouffe's political theory to climate politics and discuss how this parallels sustainability science and, in particular, the pluralism debate in ecological economics; 3) discuss how it is possible to go further and deeper by engaging agonistic pluralism with sustainability systems theory. To do this, I turn to another agonistic pluralist, William E. Connolly, whose political philosophy (i.e., the politics of complexity) provides, in my estimation, a potentially robust framework for deep pluralism between sustainability

science and environmental justice, but I reflect that Connolly's schema is limited in that it also relies on a conventionalized interpretation of complexity that fails to distinguish between "thick" and "thin" complexity. Fortunately, I explain how Connolly's own methodology – the onto-political approach to genealogical discourse analysis – can be used to tease out implicit ontological commitments and help differentiate thick from thin modalities of complexity and thereby determine anti-humanist systems theory from humanist systems theory. In so doing, I push Connolly, along with many of his favoured interlocutors (i.e., Nietzsche, Whitehead, Deleuze, and Derrida), into a more robust engagement with sustainability systems theory.

The case is made: systems theorists, with some notable exceptions, were generally well aware of the need for systems theory to grow beyond the limits of its current methods at any point in its development. Nonetheless, researchers who provisionally adopted traditionally positivist methodologies within broader fallibilist epistemologies (often coupled with indeterminate, relational ontologies) often saw their caveats simply ignored. Some systems theorists were reductionists while others were not, and still today, the efforts of the latter are measured by that of the former. In some cases, systems scientists' often extensive philosophical and ethical considerations may be offhandedly dismissed as a ruse to hide their allegedly "true" technocratic-authoritarian intentions (Lilienfield 1978)[68]. Although I reject such interpretations[69] as cynical and lacking in rigour, it is worth reflecting on how positive systems methodologies are both *received* and how they interreact within broader social and intellectual contexts, cultural imaginaries, political institutions, existing power relations, and so on. How ought concerned citizens to react when, for example, a self-described interpretivist, constructivist, or critical theorist claims complementarism when they adopt a traditionally positivistic, quantitative methodology - requiring rarified technology no less – that purports to produce predictive models that will help direct policymakers in their policy-making? The activists who opposed the policy implications of the Limits to Growth were likely unaware, or perhaps undeterred by, Meadows' anti-realist epistemology (note that she had not yet published her epistemological views at the time). The question here is, how relevant is one's epistemological or ontological views when one's methodological contributions are interpreted as

[68] In his text, *The Rise of Systems Theory*, which is the only book that purports to comprehensively critique systems theory in all its various expressions, Lilienfeld simply asserts, without any supporting argument or evidence, that the authoritarian bias of systems theory is "obvious to all" and therefore requires no further explanation. To paraphrase Nietzsche (sans his characteristic ableism) to see things that are similar and to make them the same is the sign of a biased observer. These sorts of inane, blanket assumptions are not only disingenuous, but they also undermine thoughtful critique, and this state of affairs benefits nobody in the long term.

[69] Note that I do not dismiss critics such as Bookchin when they criticize, for example, Bertlanffy, Bateson, and Prigogine because Bookchin explicitly engages with, rather than ignores, their epistemological considerations.

providing a regulative function in society, upholding current social paradigms and power relations, supporting hegemonic policy agendas?

I won't attempt to answer that question. It is somewhat like asking whether and to what extent intent should be considered when collateral harm is committed. The are too many perspectives to consider, and although they are important and relevant, even a provisional answer is beyond the scope of this text. Moreover, as a matter of historical epistemology, given a near century of debate, complementarism – whether in the form of critical system heuristics, critical realism, post-normal science, or, indeed, all conventionalized interpretations complexity - provides the foundations for "weak" pluralism between sustainability science and environmental justice at best. I attest that there are as yet under-realized and potentially fruitful opportunities for "strong" pluralism between sustainability science and environmental justice that lie at the points where neglected genealogies of systems theory intersect with post-structuralism and where both intersect with process-relational metaphysics.

To that end, the remaining three chapters of this text attempt to articulate my own vision of ecological political economy that achieves the following:

1. Following Connolly, EPE embraces an ethos of ontological pluralization that rejects absolutism (including reductionism) and relativism in equal measure. Additionally, EPE rejects deliberative political models that emphasize consensus and instead embraces the intrinsic contestorial nature of politics, replacing complementarism with "agonistic respect."
2. Following the anti-neo-Darwinist genealogy in theoretical ecology (i.e., Prigogine, Ulanowicz, and Kay), EPE acknowledges the biophysical dimension in terms of constraint and not causal determinacy. Natural laws are reinterpreted as "propensities" or "habits"[70] to make room for an indeterminate, hylozoic ontology that reflects a teleodynamic view of nature in contrast to teleology or teleonomy.
3. Following Rosen, Strand, and Cilliers, the distinction between thick and thin complexity (i.e., complicatedness) is pursued to articulate a conceptual means of distinguishing between problems that, in principle, lend themselves to technical analysis and those that do not. Extending Cilliers, EPE demonstrates a strong affinity between thick complexity and post-structuralism.

[70] Popper is generally credited with having proposed this concept, but earlier versions can be found in Whitehead and Peirce. Although I sometimes adopt the term "propensities", I note that my own epistemological assumptions correspond more closely to Whitehead and/or American Pragmatism over Popper's post-positivism.

Ecological political economy, as it is so construed, is neither ecological economics nor political ecology (although it explicitly draws on numerous sources from both fields (e.g., Albrecht, 1998; Faber et al., 1995; Farrell, 2007, 2020; Hornborg, 2017 to name only a few). Rather, EPE embraces political ecological critiques against structural functionalism without "throwing out the bathwater" and rejecting theoretical ecology. To that end, EPE revisits over-generalized and misleading criticisms of systems and cybernetics while embracing genealogies in organicism, emergentism, and holism that explicitly militate against technocratic reductionism.

Chapter 4: The Ontopolitics of Complexity

4.1: Radical democracy; agonistic pluralism

I ask the following: what remains when the "strawmen" – both in favour and against sustainability systems theory - are debunked? What discursive practices perpetuate the conventionalization of sustainability systems theory? Whose agendas, if any, do these illusions serve? Who proliferates discord, and for what purposes, in the loci of sustainability intervention where distributional justice and sustainable scale are mutually relevant? If the current state of "uncritical pluralism" is untenable, then how can sustainability science achieve a more productive and inclusive, critical pluralism? To begin answering these questions, it is first necessary to orient ourselves by asking a more fundamental question: why is pluralism desirable in the first place? Here, I turn to the tradition of radical democracy, and I endorse their vision of "agonistic pluralism".

Tonder and Thomassen provide a succinct description of radical democracy that I will attempt to summarize and relay here. Radical democratic theory, also known as either agonistic pluralism or agonistic democracy, is a post-structural (i.e., following Lyotard, Foucault, Derrida, and Deleuze) epistemological tradition that attempts to both "resuscitate" Marx's critique of modern democratic philosophy whilst also resisting the "Marxist tendency, often expressed in the name of scientific laws or historical necessities, to turn politics into an epiphenomenon of economic structures" (Tonder and Thomassen 2005). That is, as post-structuralists have always done, radical democratic theorists engage leftist politics whilst critiquing the economism of historical materialism and the essentialism of Marxist conceptual categories that threaten to subsume the plurality of ways of being, seeing, and knowing that constitute democratic life. Rather than relying on objective, exogenous categories that define the identities of political agents (e.g., the proletariat), radical democrats hold that identity is inherently unstable, incomplete, and constituted by *difference*:

> "However, radical democrats argue, the line between the two identities is in fact blurred: although the proletarian and the capitalist appear to be mutually exclusive, they both rely on a difference between what they are and what they are not (that is, the proletarian is not capitalist, and the capitalist is not proletarian). What is more, this difference is not simply yet another difference, in the sense that it would be possible to subsume it - through a dialectical resolution - under an all-inclusive identity such as a future communist society.

> Rather, it is a radical difference that - without itself being stable - constitutes the difference between the two identities. This destabilises the identities of both the capitalist and the proletarian, and indicates the futility of searching for an ontological centre that could guarantee the completeness of any social identity. Moreover, radical democrats conclude, it points to the primacy of difference over identity, asking us to accept what is the slogan of radical democracy, namely, that difference constitutes identity (p. 4)."

In addition to their critique of Marxism, the radical democratic commitment to constitutive relationality coupled with a rejection of absolute categories and extends to the radical democrats' critique of liberalism, whereby, according to radical democrats, the fact that liberal theorists promote liberal values as both abstract and a priori similarly undermines the centrality of *difference* in constituting identity by subsuming the plurality of social identities under a single conceptual paradigm and precluding the capacity of fugitive identities to contest hegemonic political formations. Rather than rejecting liberty and equality, radical democrats seek to radicalize these values, arguing that all identities, and thereby the identities of communities themselves, are inherently unstable and involved in inexorable processes of identification through contestation and differentiation. Thus, "the foundations of democracy are political 'all the way down', and … this warrants deep contestation of both social identities and political formations in the name of liberty and equality" (Tonder & Thomassen, 2005, p. 4). For radical democrats, liberty and equality, like democracy itself, are never "fixed"; we are forever involved in an infinite process of becoming (rather than "being") toward the realization of ideals that are unrealizable. Democracy, thus, exists in a perpetual tension between popular sovereignty and democratic decision-making on the one hand and individual rights and freedoms on the other. A democracy, for radical democrats, is never "complete" or fulfilled. Following Machin, "there is always a risk that democratic decision will undermine individual rights and freedoms, but there is also always the possibility that individual rights – which are always the expression of the prevailing power – can undermine the functioning of democracy… any stabilization of liberal democracy is always only a contingent expression of the tension between human rights and popular sovereignty. The status quo can always be challenged. There are always those who are excluded and unequal" (Machin, 2013, p. 90). From this standpoint, consensus-seeking takes on an altogether different valence, appearing as a means to enforce univocity and silence fugitive voices critical to hegemony and the status quo. Insofar as radical democrats maintain that antagonism and contestation intrinsically constitute democratic politics, the pursuit of consensus through deliberation acts as political violence against marginalized voices by impoverishing the heart of politics itself. "acknowledging the ineradicability of the conflictual dimension in social life,

far from undermining the democratic project, is the necessary condition for grasping the challenge by which democratic politics is confronted" (Machin, 2013, p. 90).

Radical democracy, therefore, transcends both communitarian and liberal traditions whilst maintaining an intrinsically anti-authoritarian posture. It is a "radical" form of pluralism insofar as it does not merely promote a plurality of identities and political formations; it promotes the infinite *plural-ization* of identities and political formations through differentiation and contestation. This further raises two unique concepts in radical democratic thinking: first, pluralism as anti-anti-pluralism, and second, the sublimation of antagonism into "agonistic respect" (Connolly 1995, 2008, 2009, 2014, 2017; Schoolman 2002).[71]

Regarding the first, radical democracy questions reactionary political violence against pluralization through difference and contestation, and this is how radical democracy avoids the fallacy of "anything goes" pluralism. For Connolly, the "ethos of pluralization" represents militation *against* absolutism (i.e., anti-pluralism). In this way, pluralism is interpreted in both positive and negative modes: pluralists *promote* pluralization through contestation and differentiation, and they *oppose* attempts to eliminate difference either through coercion, domination, exploitation or even consensus building. Radical democrats *affirm* contestation and the intrinsic rowdiness of political life when it is sublimated through political contests when the participants commonly agree to curtail the devolution of contestation into violence. Agonistic respect is, therefore, necessary to sublimate contestation into the synthesis of new political formations and identities. Consensus, they argue, stifles pluralization and radical difference through rationalist truth claims and objectivist imputations to specific policy agendas. In so doing, deliberative democracy, according to the radical pluralists, thereby paradoxically generates reactionary extremism against the deliberative political process itself by ignoring the "element of passion" that is intrinsic to political life and reducing it to a "rationale of procedural" process of progressively refining policy science (Tonder & Thomassen, 2005, p. 4-5). Radical democracy, thus, does not constitute a form of illiberalism, nor does it make apologies or affordances for illiberalism. However, radical democrats do seek to understand the mechanisms by which liberal philosophy, politics, and rhetoric contribute to the very reactionary extremism it aims to eliminate through rational discourse.

[71] Farrell (2020, p. 10) proposes a similar concept: "epistemological solidarity … a compassionate regard for the limits of one's own knowing and the validity of other ways of making sense of reality."

4.2: Agonism and Parallax

Machin (2013) explains how the paradoxical rise of extremism as a reaction to the marginalization of difference unfolds with respect to the politics of climate change. She challenges the conventional wisdom surrounding climate change voiced by Hans Timmermans in the introduction to this text (i.e., that climate change is not political) and argues in detail by eminent the eminent social theorist Anthony Giddens. For Giddens (2009), like Timmermans, climate change ought not to be a "right-left" issue, but it has become one because the electorate is collectively unable to grasp the dangers associated with climate change because those dangers are intangible, invisible, and non-immediate.

> Giddens sees the democratic population as unable adequately to comprehend the situation, although at the same time he seems to see himself as capable of comprehending it, as he is writing about it. But rather than the inability of the demos to grasp the situation rationally and to see beyond their immediate self-interest, perhaps the problem is that the situation isn't grasped in the way it is routinely, hegemonically, construed. Perhaps the lack of decisive action should not be regarded as an exception to the way climate change is generally depicted, *but rather as a symptom of it*. Perhaps the problem is not the *paradox* but rather the *parallax* of climate change (Machin, 2013, p. 88).

Machin invokes Žižek's use of the astronomical concept of the parallax to describe climate change. For Žižek, parallax is the 'constantly shifting perspective between two points between which no synthesis or mediation is possible… there is no rapport between the two levels, no shared space. …' (Žižek, 2006, p. 4). For Machin, the parallax represents "the inevitability of observing a certain object only indirectly, and when the different observations are incommensurable (Machin 2013, p. 88).

> Perhaps climate change is a parallax in this sense, something that cannot ever be directly observed but is seen from a multiplicity and diversity of stand points. Giddens seems to suggest that its mirrored surface, in which we see ourselves and our politics, is itself distorted when looked at from the wrong direction, and that only some see it truly straight on, free from any distraction by its warped reflections. I contend that there is no one correct position from which to assess climate change. Perhaps this object we call climate change is a shifting mirror ball that is observed from very different positions. Its reflective surface scatters images to and from all directions; we catch only glimpses of what others might see of themselves in it.

> This might suggest that disagreement about climate change is inevitable, a result of there being no one right way to see it and assess it. But should this disagreement be regarded as a problem? Theorists and policy makers of climate change often shy away from conflict, either by denying any conflict exists (ecological modernization), or by suppressing it through the assertion of a 'common good' (green republicanism), or by explicitly dismissing democratic politics (eco-authoritarianism), or by theorizing the transcendence of conflict through rational discussion and mutual understanding (deliberative democracy). The aim is to suppress conflict so that decision making about climate change can go ahead smoothly. But, as we have seen, there are problems with all of these approaches and there has been a distinct lack of conclusive decision making about climate change…
>
> *Contrary to dominant understanding, decision is underpinned not by consensus but by disagreement, for without a choice between real alternatives there can be no decision*. I will explain that this disagreement cannot be overcome through discussion, as implied by deliberative democracy; differences are not left behind during the debate, but rather subsist all the way through. The aim for a climate consensus – in both science and politics – depoliticizes the issue and undermines the possibility of climate change politics. The assumption and aim of consensus, in the meantime, actually encourages those disillusioned and excluded by it to adopt the only alternative, a moral and identitarian extremism. Giddens is right when he diagnoses the lack of political inclination for tackling climate change. But this, I argue, might well be precisely because of the promotion of rational consensus, not despite it (Machin, 2013, p. 88-89).

Here, Machin's critique of Giddens' assessment of the politics of climate change bears a striking resemblance to my discussion of the pluralism debate surrounding ecological economics from Chapter 2. For Costanza, following Deborah Tannen, there is no distinction between agonism and antagonism in the all-pervasive "argument culture." For Spash, there is no recognition of the potential value of conflict nor the possibility of sublimating conflict *within a pluralistic discourse*. For both, the only appropriate reaction to a "big tent of antagonists with conflicting ontologies" is to create a smaller tent of consensus whilst excluding critical voices. The difference is that Spash seeks to standardize and structure a particular form of conflict against an approved antagonist (i.e., orthodox economics). In contrast, Costanza seeks "mutual understanding" with a hegemon that demands conformity. Melgar-Melgar and Hall seek to subsume -and thereby dismiss – democratic politics under the rationality of social energetics

in the name of opposing ecological modernization (i.e., ecomodernism). Once again, all of these approaches suppress pluralism -either through domination, consensus, or exclusion - for the sake of suppressing conflict. For Machin, then, ecological economics appears as a smaller subset of a larger debate within the politics of the environment, and many ecological economists are prone to the same mistake of attempting to reduce the "parallax" of climate change to a rational and procedural matter of accumulating and operationalizing the "predictive truth-machine" of scientific knowledge in which "scientific facts are expected to reveal to us what to do, emptying politics of any disagreement or decision."(Machin 2013, p. 94). In both cases, by framing the problem as a matter of science, sustainability scientists delimit the scope of contestation to a polarized binary; "either accept or deny". In this way, stochastic antagonism and post-truth extremism become the only viable means of contesting and resisting the objective political imputations of sustainability science.

Most strikingly, Machin's concept of the parallax is *equivalent* to the concept of "thick complexity" (i.e., semiotic complexity, i.e., complexity as multiple, non-equivalent descriptive domains) (Farrell 2009; Giampietro 2003) outlined in chapter two of this text, and this helps to better illustrate the contradictions caused by the conventionalized concept of complexity broadly in use in sustainability science. For Costanza, complex problems are precisely those problems in which disagreement and debate are "inappropriate." Following Tannen, he interprets violent extremism as stemming from disagreement, which stems from ignorance. Disagreement is, therefore, something to be marginalized in order to minimize contestation and extremism. Although Costanza acknowledges that complexity engenders "multiple perspectives," what he is actually promoting is multiple perspectives within a single, broader consensus, where the consensus represents the perspective in which complexity theory can be reduced to a predictive "science of complexity" that serves the positivist truth machine of scientific knowledge and evidence-based policy. For Machin, by contrast, violent extremism is a symptomatic consequence of elements within the electorate feeling alienated from the potential to engage in political life; disagreement is something to be welcomed as constitutive of democracy itself. From her perspective, complex problems are the sorts of problems in which not only disagreement but also conflict becomes unavoidable, inevitable, and necessary.

The strong resonance between Žižek's concept of the parallax and thick complexity serves as one indication that there exists a strong overlap between the complexity discourse and the discourse of radical democracy and that the insights from radical democracy have the potential to further not only our understanding of the politics of climate change but also the politics of sustainability more

generally[72]. For ecological economists, in particular, there are a series of insights that agonistic democracy might afford. On the one hand, ecological economic approaches that seek deliberation and consensus with neoclassical and neoliberal economic theory engenders a theoretical synthesis that imbues the latter with the progressive cultural and political cachet of the natural sciences. In other words, one of the risks of embracing Natural capital and payments for ecosystem services in scientific policy debates is the validation of neoliberalism as the most appropriate means of determining environmental policy, whereby legitimate critique of environmental economics can be construed as a matter of "science denial" if not an expression of self-indulgent "argument culture" (note that the term "argument culture" is precariously close to the term "cancel culture" that is implicated in the right-wing war on "wokeness"). Such a move inevitably undermines the ontological and axiological divisions between ecology and economics that Norgaard insists exist but struggles to articulate. However, in attempting to resist the subsummation of ecological economics under orthodox economics, ecological economists also fall victim to a similar impulse; the desire to grasp something *concrete* such as a hierarchy of sciences, or a reductionist theory of everything, that is capable of acting as either barrier or bludgeon against antagonists. For Machin, however, the more concrete the implement used to enforce conformity is, the more *affectively* irrational the response from reactionary extremism becomes until, ultimately, the opportunity to sublimate conflict is lost and political violence ensues.

This presents another problem not directly handled by radical democrats whose intellectual gravitas ascended dramatically as the political climate radically adjusted to the sudden rise of right-wing populism and climate denialism. That is, while the pursuit of concreteness and immutable truth may not be in and of itself an authoritarian impulse, it does quite obviously appeal to authoritarian sensibilities. By promoting theories that constitute environmental determinism and social Darwinism, or even by simply failing to critique or recognize these theories as such, sustainability scientists risk providing conceptual tools for extremists. Concerningly, radical right-wing opposition to environmental conservation is a cultural and political phenomenon that is most prevalent in the United States, whereas "eco-fascism" is a more prevalent form of right-wing extremism in Europe. Concerningly, there is evidence that this formerly European trend is becoming a global trend, and, with Trumpism seemingly in retreat in the aftermath of the January 6 Committee and the 2022 General Election in the United States, eco-fascism may play an important factor in shaping right-wing extremism in the decades to come.

[72] Farrell (2009) has made similar comparisons between Strand's "thick complexity" and Cilliers' "general complexity." Farrell prefers the term, "thick view of complexity," over "thick complexity."

Over the course of the still ongoing COVID-19 pandemic, both vaccine advocates and "anti-vaxxers" invoked similar forms of social Darwinism in their rhetoric to opposing ends. Eco-essentialism is also implicated in another epidemic ravaging the United States: the ever-increasing trend of politically motivated, stochastic terrorism perpetuated by right-wing extremists. The Buffalo perpetrator's 180-page diatribe, initially posted to the gamer social media app, Discord, rationalized his actions using similar eco-nativist rhetoric espoused by Hardin. The section of his text dedicated to the environment claimed that the right could no longer afford to cede environmental issues to the political left. A significant portion of that text directly plagiarized another text written months before by the Christchurch perpetrator, a self-described "ethno-nationalist, eco-fascist" who blamed climate change on overpopulation in the global south (see Farrell-Molloy & Macklin, 2022 for an analysis of both perpetrators' diatribes. The original texts are classified).

This discussion reveals the array of intersections across, and the potential for synthesis between, technological fetishism, technocratic optimism, and eco-fascism. They are unified in a monistic ontology of optimization and efficiency. Following Hardin, and contrary to popular perception, eco-authoritarians portray themselves as *nurturing* diversity by enforcing social hierarchy and ethnonational homogeny. Through biological essentialism, eco-authoritarianism also forms an easy alliance with transphobes, claiming to be feminists, who have proven altogether willing and eager to engage with the radical right in a coordinated effort to marginalize and scapegoat trans-gendered individuals by reviving the tired, denigrative trope that they are sexual predators[73]. As with the biologism of Nazi ideology that associated interpretive arts and intellectualisms with "degenerate" racial impurity, pluralism is once again pathologized as an expression of the collective "woke mind-virus" that must be expunged for the sake of preserving civilization itself. Increasingly, appealing to eco-fascism has become an important source of recruitment for the American far-right amongst the otherwise strongly socially progressive Gen-Z demographic. This coordinated campaign by well-resourced right-wing operatives seeks to establish biological and ecological essentialism as organizing concepts for far-right extremism over the coming decades. As one commentator has suggested, right-wing extremism cannot deny climate change indefinitely, and, as the acts of terrorism in Buffalo and Christchurch illustrate, there is no reason to believe that ecologically-oriented right-wing extremism will be any less dangerous. The core point here

[73] Note that this trope was once extended to all communities under the broader umbrella of LGBTQ+ by social conservatives. This time, however, it is specifically targeting the trans-gendered community, and with the full participation of many "log cabin" conservatives who have garnered a degree of acceptance within the broader spectrum of American conservative politics.

is that neo-liberal climate denialism and eco-fascism cannot be addressed with environmental determinism or ecological modernism, as all are predicated on different but related and equally pernicious social Darwinian ontologies. Ontology is, therefore, a key point of intervention, and this insight must constitute a key frame of reference moving forward. The question we must ask is, what are the ontological similarities between sustainability science, neoliberalism, and eco-fascism such that the former can be quickly and easily, adapted for use by the latter two? And how can we adapt the ontological commitments, epistemological assumptions, onto-political interpretations, and explanatory frameworks currently associated with sustainability science so as to disrupt and destabilize these possibilities while simultaneously creating new possibilities for pluralism between sustainability and environmental justice?

4.3: Connolly and the Politics of Complexity

To help us navigate both the biophysical and ideological dangers inherent within the parallax of the sustainability crisis, I turn to the radical democratic theorist William E. Connolly. In doing so, my argument now diverges significantly from that of Machin, but with the intention of ultimately complementing her position and expanding it to better encompass the whole of sustainability science, which, as I have established, relies heavily on systems concepts such as complexity, emergence, nonlinearity and hierarchy. Whereas Machin primarily invokes Chantal Mouffe to support her insights on climate change, I argue that Connolly is a more appropriate point of reference and inspiration for sustainability systems theory for several reasons. First, once again, sustainability systems theory is broadly and frequently problematized for its association with implicit ontological commitments that reproduce the ontology of optimization, environmental determinism, and social Darwinism. As noted, these claims are often due to speculation or misunderstanding, but they are also often well-grounded (as in, for example, Taylor's critique of Odum or Mirowski's critique of Von Neumann). Critical systems theorists have long recognized the need for a genealogy of the many strands of systems theory to sort the grounded claims from the red herrings, and, as I will argue, Connolly's unique onto-political approach to genealogy constitutes a powerful means for differentiating the two[74] because it is chiefly concerned with uncovering implicit ontological commitments. Second, in addition to the potential that Connolly's methodology affords in this context, I maintain that Connolly's *ontology* is equally essential

[74] As noted, I was implicitly applying Connolly's approach in chapters 2 and 3 of this text, but I have withheld describing it in detail until this point because Connolly's methodology must be understood in the context of his *ontology*, and a lengthy excurse on Connolly's ontology would not have made sense earlier in this text.

for both sustainability scientists and environmental justice advocates precisely *because* he engages the concepts of holism, emergentism, organicism, relationality, and complexity in such ways that radically preclude the possibility of their co-optation for authoritarian ends. As I will explain, ontology and methodology are recursively interrelated in Connolly's thought.

Connolly's ontological approach to genealogy is sometimes referred to as "onto-politics" or ontological political theory (OPT). Onto-political genealogy is both an extension to and an adaptation of, Foucaudian genealogy, but one that is both informed by and centrally concerned with the ontology of both the subjective genealogist and the object of genealogy. In Foucauldian thought, genealogy is the political deployment of "archaeology" [75]. Archaeology, in turn, constitutes the mapping of the implicit rules enacted by subtle discursive practices ("facile gestures") that delimit the boundaries of acceptable conceptual possibilities within a given historico-discrusive context: "If we were to characterize it in two terms, then archaeology' would be the appropriate methodology of this analysis of local discursivities, and 'genealogy' would be the tactics whereby, on the basis of the descriptions of these local discursivities, the subjected knowledges which were thus released would be brought into play". Following Anaïs, (2013), genealogy constitutes "an ethos of analysis rather than a strict post-structuralist methodology… [it is] less a methodological approach than it is a set of conceptual practices and habits of mind, realized in 'several theoretical and practical gestures' (Saar, 2002, pp. 231–232)" (Anaïs 2013, pp. 124). Archaeology examines the structure of discourse descriptively and without judgment, whereas Foucauldian genealogy concerns the normative and political dimensions of discourse. Archaeology describes the rules of a given discourse, and genealogy examines the ways in which power18 creates and re-creates those rules. Archaeology is, therefore, a prerequisite for genealogy. Genealogy is the "strategic development of archaeological research" (Kendall and Wickham 2011, pp. 31), acting as a "means through which social scientists can attempt to investigate the 'history of the present' first by mounting an organized assault on the intellectual object that we take history to be and by unsettling and disrupting the political and intellectual grounds upon which we rest our inquiries" (Anaïs 2013, pp. 126).

[75] Following Kendall and Wickham, archeology involves the following: 1) to chart the relation between the sayable and the visible; 2) to analyse the relation between one statement and other statements; 3) to formulate rules for the repeatability of statements…; 4) to analyse the positions which are established between subjects…; 5) to describe 'surfaces of emergence' - places within which objects are designated and acted upon; 6) to describe 'institutions', which acquire authority and provide limits within which discursive objects may act or exist, [and]; 7) to describe 'forms of specification' which refer to the ways in which discursive objects are targeted" (Kendall and Wickham 2011, pp. 26).

Connolly's onto-political theory rejects and seeks to dissolve, conceptual absolutes that are implicit in ontological commitments. Following Connolly: "We must not imagine that the world... is... the accomplice of our knowledge; there is no prediscursive providence which predisposes the world in our favor." However, the key to Connolly's approach lies in the reflexive interaction between ontology and methodology. For Connolly, "A method of research is apt to express a set of metaphysical commitments to which the Methodists embracing it are attached." Intriguingly, Connolly neither exempts himself from this assessment; the genealogist is always similarly subject to the method they are subjecting others to, and this is no less true of Connolly or the current text. For Connolly, genealogy is meant to further agonism rather than antagonism, and it does so by fostering an air of "presumptive generosity", "agonistic respect", and a distinctly pluralistic, ethical sensibility:

> An ethical sensibility, anchored in an ontoalogical problematic, rendered through genealogies of the possible, cultivated through tactics applied by the self to itself, embodied as care for an enlarged diversity of life in which plural constituencies coexist in more creative ways than sustained by a communitarian idea of harmony or a liberal idea of tolerance, politicized through a series of critical engagements with established social apparati of good/evil, normal/ abnormal, guilt/innocence, rationality/irrationality, autonomy/dependence, security/insecurity (Connolly, 1993a, p. 378-379).

This ethical sensibility – the "ethos of pluralization" - implicit in genealogy affirms an ontological "protean diversity of being" far exceeding what is possible to know. Connolly, thus, reads Foucault along two intersecting registers: "Nothing is fundamental' in the sense that no fundamental Law or Purpose or Contract governs things, and; "Nothing is fundamental" in the sense that energies and forces exceeding the social construction of subjects and things circulate through "gaps" in these institutionalizations" (Connolly, 1993, p. 377). "Genealogy treats unities and ideals typically construed to be expressive of nature, reason, human embodiment as such, or history *as if they were social constructs subjugating elements within them recalcitrant to the unity established*. It expresses, then, a view of history and an ontology at odds with those views which prop up rationalism and expressivism" (emphasis mine). Critically, for Connolly, it is precisely these ontological "energies and forces" that are essential in the maintenance of multi-faceted democracy.

> A viable democratic ethos embodies a productive ambiguity at its very core. Its role as an instrument of rule and governance is balanced and countered by its logic as a medium for the periodic disturbance and denaturalization of settled identities and sedimented

> conventions… If the democratic task of governance ever buries the democratic ethos of disturbance and politicization under the weight of national consensus, historical necessity, and state security, state mechanisms of electoral accountability will be reduced to conduits for the production of internal/external others against whom to wage moral wars of all too familiar sorts (Connolly, 1993a, p. 379-380).

Consistent with other radical democrats such as Mouffe, Honig, Machin and others, Connolly seeks to sublimate such "moral wars" by cultivating *reciprocal logics of interaction, exchange and learning which can increase the responsiveness of dialogical partners*" through a shared posture of "agonistic respect" toward one's interlocutors.

> Agonistic respect, as I construe it, is a social relation of respect for the opponent against whom you define yourself even while you resist its imperatives and strive to delimit its spaces of hegemony. Care for the strife and interdependence of contingent identities, in which each identity depends upon a set of differences to be, means that "we" (the "we" is an invitation) cannot pursue the ethic that inspires us without contesting claims to the universality and sufficiency of the moral fundamentalisms we disturb-hence genealogy and deconstruction. But this antagonism can be translated into something closer to agonistic respect in some cases, as each party comes to appreciate the extent to which its self-definition is bound up with the other and the degree to which the comparative projections of both are contestable. We opponents can become bonded together, partially and contingently, through an enhanced experience of the contestability of the problematic each pursues most fervently (Connolly, 2002, p. 155-156).

Nevertheless, pluralism, so construed, does not mean "anything goes." Rather, the "ethos of pluralization" serves as a positive affirmation of not only pluralism but also *pluralization* and the "protean diversity of being." It is here where Connolly recognizes that the genealogist cannot help but reveal their own implicit ontology, and the imputations those ontologies carry when they are drawing out the ontologies of others. This is not a problem so much as a reality to be embraced and rendered as transparent as possible. This is operationalized in a "double-entry orientation" "that both critically uncovers covert (and problematic) ontological assumptions within the practices and norms of contemporary liberal-democratic life (and their pernicious effects), that is, its critical task, and reconstructs those norms informed by alternative ontological figurations they argue have validity, that is, its normative task" (Chin 2021).

As discussed in the introduction of this text, it is Connolly's "double-entry orientation" that I am employing in my analysis of the discourse surrounding pluralism and sustainability systems theory. Chapter 2 of this text sought to expose – through conceptual, historical, and methodological linkages – ontological commitments that are subtly implicit. (In the spirit of agonistic respect, however, and in the hopes of cultivating responsiveness with those whom I critique, I also seek to address what I consider to be misplaced criticisms resulting from over-generalizations and subtle misunderstandings). This point in the text, therefore, represents a fulcrum, if you will, where I shift from the "critical task" to the "normative task" of ontopolitical genealogy. In Connolly's terms, the goal now is to "work on" theoretical ecology; to supplement it with concepts and themes that I consider more generative, more responsive to critical concerns, and more emblematic of the genuine difference between ecology and economics that Norgaard claims.

4.4: More Human Than Human

Beginning this process is simple; I once again follow Connolly, who, throughout decades of meditations on multi-faceted democracy, agonistic pluralism, aspirational fascism, and the "fragility" of intersecting human and non-human, self-organizing processes, has developed an ontology that I also affirm, but approached from a distinctly different trajectory. Connolly, in other words, is a post-structuralist political theorist who has gleaned key insights in post-structuralism from the field of complexity theory. We are both unavoidably limited by "reaching" beyond our respective discourses, but this also means that his analysis may complement mine and vice-versa. Although his command of the concepts of impressive, Connolly is, by his own admission, limited in the scope of his familiarity with the systems discourse itself. I am the opposite; a systems researcher with a background in political theory who has gleaned key insights into complexity from post-structuralists such as Connolly and others whom he aligns himself (namely Foucault, Derrida, Deleuze and Guattari). Connolly's critics have noted that his use of the term "complexity" is problematic because the term is polysemic and because he does not specific which interpretation of complexity he is employing. I can be of assistance in this matter by locating specific parallels to Connolly's argument from within the systems discourse itself. Connolly, in exchange, extends complexity theory by articulating key distinctions (that are either implicit or absent in systems discourse) arising from his pluralistic process-ontology.

To begin, I will first examine how Connolly's ontology engages key systems concepts: namely, holism, emergence, and self-organization. The following passage paints a summary portrait of Connolly's ontological commitments.

> The world of temporal force fields includes solar energy fields; radioactive decay in the interior of the earth that periodically activates volcanoes; flows of molten metal in the lithosphere that periodically erupt on the crust as mountains, earthquakes, and volcanoes; slow movements of tectonic plates that change the composition of continents and oceans and occasionally generate earthquakes and volcanoes; ocean current systems with a degree of self- maintaining power and susceptibility to change by tectonic plate activity, atmospheric changes, changes in the ratio of ice to water, changes in water temperature, and differentials of salt density between sections of the ocean; a climate system with both impressive powers of self- maintenance and susceptibility to feedback loops with other systems, including capitalist expansion, shifts in ocean currents, and changes in the ratio of ice to water in oceans; a system of species evolution, periodically modified by asteroid showers, aesthetic tastes, climate change, gene and disease transfers across species, changes in the pace and scale of world travel, and capitalist evolution; a magnetic field providing the Earth with its atmosphere, connected to several other systems; systems of soil self-maintenance, imbricated with species evolution, climate change, capitalist agriculture, and oil spills; a civilizational system with internal rhythms of change that can accelerate, turn, or become overwhelmed by a perfect storm of changes in climate, soil quality, disease transmission, volcanic eruptions, military invasion, and new intensities of regional and/or class resentments; regional religious systems, fluctuating in their degree of affirmation or resentment of the most fundamental terms of human existence, intercoded at various times with several of the systems noted above; bacterial and viral disease species jumps, some enabling human life and others threatening it through interaction with systems of plane transportation, livestock, droughts, soil erosion, and so forth; a few hundred years of capitalist expansion, tethered by a thousand threads, pulleys, and osmotic processes to these other systems; and interacting secular, theological, and philosophical cultures, many of which have heretofore been organized around contests over whether an omnipotent God dominates creativity, a benign telos governs things, or human beings can master the forces around them to become supreme (Connolly, 2013, 28-29).

Connolly's ontology clearly contains a plurality of ontic objects, and yet it is relatively simple to grasp. These "temporal force fields" constitute an array of both cyclical and linear processes that operate at vastly differential capacities of self-organization over equally vast spatial and temporal horizons. Critically, these fields are "imbricated", i.e., overlapping, intersecting, interjecting, interposing and, overmatching. In other words, although each of these types of systems are constituted by their own dynamical patterns and habits, loosely governed by unique control variables, they affect one another in myriad ways such that no field is reducible to the others. This view, in other words, affirms self-organization, interdependence and relational holism. Connolly describes his epistemological approach to understanding such processes as "immanent naturalism" - i.e., naturalism "that doesn't seek ultimate explanations, ahistorical forces, or transcendental frameworks to give meaning to the world; rather, it finds meaning enough in the world as it is experienced by mortals like us". It is also "entangled humanism" in that this approach affirms the agential human subject, but also recognizes the array of both biotic and abiotic processes that act as constraints on the possibilities of the human sphere.

Humanism is a complicated term largely because it is implicated in both rationalism and naturalism, and both traditions have a complicated relationship with agency. Whereas initially, humanism was meant to affirm human agency against the teleological vision of medieval scholasticism, the introduction of rationalism soon turned this assertion on its read. Humanism led to rationalism, rationalism led to naturalism, and naturalism led to a new interpretation of determinism according to "scientific laws," which eventually, through thinkers like Laplace, disposed of the emphasis on agency that defined humanism in the early Enlightenment period. To make matters more complicated, the idea of "scientific laws" historically derives from the older theological concept of "natural law", i.e. the teleological order imposed by God (Ruby 1986). In this way, we see how the Enlightenment did not constitute a rejection of Christianity but rather the rejection of the Aristotelian component of medieval scholasticism that had become synonymous with the institution of Christianity up until that point. Following the historian Brian Easlea, and his seminal text¸ *Witch Hunting, Magic, and the New Philosophy* (1980), the mechanistic-legal tradition in science (associated with Gallileo and Newton, leading to Laplace and, ultimately, Spencer and Darwin) ultimately succeeded over competing traditions (e.g., the neo-Platonic, magical spiritualist tradition associated with Schelling among others) in enlightenment science precisely *because* it could be, and was, easily adapted to reinforce the existing theocratic power relations of the day. Following Easlea, in many ways, the scientific revolution was predicated on the Spanish Inquisition, which effectively served to forcefully eliminate the competitors to the legal mechanistic tradition. One will note that these competing heuristic traditions were generally non-formalized, codified in local

knowledge and tradition, and conducted principally by women - providing healthcare services for other women- who were summarily persecuted as witches. This is why it is so easy for contemporary liberal philosophers such as, for example, Sagoff (Sagoff 2015, 2016) to selectively claim that Spencer, and the entirety of theoretical ecology thereafter, derives from theology[76] because, in fact, this claim could be generalized to the majority of enlightenment science as a whole. While Sagoff is likely correct in his speculation that Spencer sublimated Christianity in this search for universal causal laws, but he is selectively applying this argument to Spencer when it could be extended to all other materialists and positivists. Regardless, when I write normatively about "humanism", and, by extension, anti-humanism, I am doing so with an emphasis on the original, agential interpretation of the term that was later displaced by legal-mechanistic thinkers such as Laplace, who paradoxically made it their purpose to disprove human agency, and, by extension, the existence of purpose altogether[77]. When Connolly writes pejoratively about humanism (see Connolly 2020, p. 18-20) and the need to reject it, he is interpreting humanism in a later historical, secular-rationalist sense of the term (which many authors paradoxically associate with anti-humanism[78]). He and I converge in that we both agree on the need for "entangled humanism" that affirms human agency and "strives to acknowledge without existential resentment the constitutive imbrications and interdependencies" that that agency encounters, affects, and is affected by within a plurality of human and non-human, living and non-living processes operating at differential capacities of self-organization over varying horizons of time and space. This recursive epistemological

[76]From Sagoff (2013), p. 253: "I believe that 20th-century ecological science … substituted the word 'Evolution' for 'God' but otherwise retained a Great Chain of Being framework that came directly from natural theology. The Christian belief that mankind is 'fallen' and nature divinely planned may account for the apparent plausibility of ecosystem theory, in other words, the credulity with which people accept the view that human activity is external to and disturbs nature's authentic balance, design, integrity, complexity, adaptiveness, resilience, stability, structure, function, process, pattern or whatever it is that is lost as a result of human depredation. The long-time editor of Land Economics, Daniel Bromley, has written, 'Contemporary ecology is nothing but intelligent design for agnostics.'" This last sentence is attributed to a snide, one-line comment that Bromley made in response to Sagoff's article, *The Rise and Fall of Ecological Economics* on the Breakthrough Institute's website. The fact that Sagoff must rely on quoting what amounts to a Reddit post in support of his "belief" is telling.

[77] Note that this issue lies at the heart of Georgescu-Roegen's critique of neoclassical economics: "we must not insist on asking always" why." For some problems we may achieve a greater insight if we ask "for what purpose." Even biologists bent on avoiding anything that might smack of vitalism admit that there is some advantage in classifying some biological phenomena as quasi finalistic. But this verbalist legerdemain may do only for other species than man. Man knows (and by the most direct way) that a *causa finalis*, not a *causa efficiens*, makes him work for an academic degree or save for old age. To deny that man, in his deliberate actions, is animated by a purpose would be a flight from truth. The recurrent writer who announces that his purpose is to prove that the concept of purpose is a bogey constitutes- as Whitehead amusingly observed-a highly interesting subject of study" (Georgescu-Roegen, 1972, p. 16).

[78] This will become apparent in Chapter 5 when I discuss Luhmann, whose social systems theory is broadly considered "anti-humanist" because it precludes the possibility that human agency can have any bearing on the course of social evolution.

and ontological approach addresses a persistent problem that humanism shares with the functionalist philosophy of life: that is, life when viewed through the lens of genetic or environmental determinism, ceases to be distinguishable from non-life, and the problematic legacy of functionalist interpretation of social organisms -whether we are referring to societies or humans themselves – stems from the fact that these "organisms" are actually machines in disguise. Entangled humanism, by contrast, provides an image of the human subject that is more *human* than "human" in the secular humanist interpretation of the term[79].

What else do "entangled humanism" and "immanent naturalism" do for us within the context of the problématique, as I have construed it here? It allows us to affirm theories relating to nonhuman, self-organizing entities of the sorts brought forth by, for example, Odum or Holling as etiological rather than teleological and descriptive rather than normative, and with the guardrails that such descriptions of self-organizing processes are both contingent and causally interrelated to an extent far beyond the possibility of reducing our ontopolitical (i.e., social-ontological) interpretations to them. It disarms these theories' use as an instrument of both liberal-objective policy science (i.e., politics as procedural) and reactionary authoritarian reductionism. It counters the logic of economism that underwrites neo-liberal capitalism. It affirms the ecological economic premise that economics cannot transcend the biophysical world while also rejecting the notion that value is reducible to biophysical quantities (i.e., emergy accounting and energy theories of value). It affirms self-organization whilst rejecting the idea that *all* self-organization is attenuated to a single, transcendent and monistic logic, either of the market, or of energy, or some evolutionary, idealistic singularity. Such an idea, I maintain, provides an organizing mode for a new discourse in a distinctly "ecological" political economy that, if adopted by sustainability scientists like ecological economists, some of whom, in doing so, would need to abandon any pretense of technocratic privilege over and above environmental justice, forcing them to engage with the logic of power, colonialism, and techno-capitalism by ridding those objects of naturalistic pretense, and reinvesting them with accountability, rendering it impossible to ideologically disarm[80] their consequences.

The obvious corollary to the question, "What do we gain?" would be, "What is lost?" and the obvious answer, generally provided by realists, is "objective truth" and the possibility for accountability that it

[79] The phrase, "*more human than human",* is also the title of a 1995 White Zombie song that was, in turn, inspired by the 1982 film, *Blade Runner*. Both the song and the film explore themes that overlap with the point I am making, but I will not discuss them here.
[80] Borrowing Hornborg's phrase, "the ideological disarmament" (Hornborg 2009).

provides. There are no absolutes in Connolly. Entangled humanism is, therefore, "not presented as a creed everybody everywhere should embrace. No cross-regional pluralist assemblage could or should be anchored in such a universal. But it is perhaps an idea that many in the old capitalist centers— still haunted by the ghosts of mastery, sociocentrism, and human exceptionalism— might internalize to better open lines of exchange and agonistic respect with other traditions" (Connolly, 2020, p. 11). In my assessment, sustainability science is still "haunted" by mastery, technocratic optimism, and human exceptionalism. It is, therefore, a realm in which this idea may yield greater responsiveness with critics and new potentialities as a result.

The key insight lies in what Connolly means when he writes of "differential capacities of self-organization" and how we are meant to organize and operationalize our understanding of such a pluralistic ontology. The fact remains that the current post-positivist paradigm in science continues to yield compelling results because many systems are predictable; they exhibit very limited capacities for self-organization and agency. Other systems, namely human, social, psychological, or ecological, demand more localized and contingent models that inevitably fail due to inherent uncertainty. How are we to organize our understanding of the difference between systems that can be meaningfully modelled and those that cannot? To put this in political terms, how do we navigate the need to recognize problems as post-normal, and the dangerous misinformation and prejudices associated with the post-truth paradigm? Tying back to Machin, a related question would be, how do we recognize the threshold between extremism and necessary political contestation[81]?

Postnormal science (Funtowicz and Ravetz 1993, 1994, 2003) provides a partial answer to all of these questions by assessing problem situations according to their relative degrees of uncertainty and the decision stakes involved. Following Funtowicz and Ravetz, it is necessary to undertake different approaches, in both policy-making and scientific sense-making, depending on the relative degrees of uncertainty and the relative intensity of the decision stakes in any given problem context. For Funtowicz and Ravetz, there is a qualitative threshold beyond which applied science gives way to professional expertise, which, in turn, gives way to post-normal science when we are dealing with situations involving systems that exhibit emergent complexity. Farrell and Saltelli (2007) provide an instrumental breakdown of how this can be instructive for both scientists and policy-makers (figure 8).

[81] See also Farrell 2020.

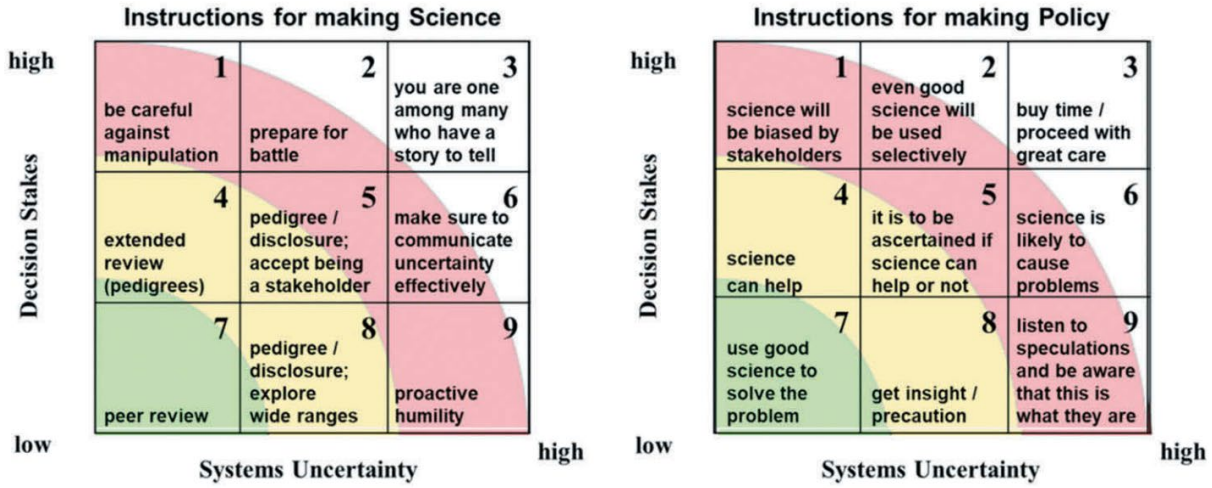

Figure 8: "The anatomy of destabilized fact claims under post-normal science conditions" from Farrell, 2020, p. 7 (original: Farrell et al., 2007).

Post-normal science provides and robust framework for inter-disciplinarity and trans-disciplinarity in many discourses, including, but not limited to, sustainability science, environmental sociology, ecological economics, and agroecology. I also affirm post-normal science, but I recognize that it fails to make certain key distinctions that render it of limited use when attempting to address the core problématique arising out of my discussion. In other words, I agree that such thresholds constitute a useful means for organizing our understanding around different types of problems and the scientific approaches used to address them, but the problem is, how do we recognize thresholds themselves, and how do we know when we have crossed them? As I will argue in the next chapter, sustainability scientists often get this part wrong, and the fuzziness of the distinction between the "thick" and "thin" complexity (or, if you prefer, between complicatedness and complexity) opens the door to complex problems being interpreted - by technocrats and eco-authoritarians - as merely complicated, and complicated problems being interpreted - by, for example, climate deniers - as complex and, therefore, beyond the possibility of understanding.

Here is one instance in which Connolly's ontology might be instructive for sustainability science and policy making. Connolly, following Deleuze, who himself was influenced by Whitehead[82], affirms a

[82] It is noteworthy that Whitehead is among the most famous and influential mathematicians in history. His mathematical magnum opus, The Principia Mathematica, co-authored with his former student, Bertrand Russell, established the congruence between logic and mathematics. As a result, it is no far stretch to suggest that logical

hylozoic, process-relational ontology. What this means is: 1) every "actual entity" with ontic status retains some measure of experience, creativity, and agency; 2) all entities are *processes* as opposed to substances, and; 3) all relations are internal and constitutive. In Whiteheadian terms, my experience of the mug next to me is, in fact, a process of prehension - the ingression of the mug into my being, changing me and partially constituting my continually renewing self-as-a-process-of-becoming. This is fundamentally different from mechanistic, substance ontologies in which relations are external (i.e., non-constitutive) and objects act upon one another[83]. For Whitehead, such an ontology was necessary to address the "bifurcation of nature" we find in mind-body dualism or agency structure dualism. We can account without contradiction for the existence of agential, creative entities emerging in a universe of seemingly inert objects because all objects are relational processes constituted by affect-imbued experience: "drives". For Whitehead, the creative drives that bring processes together into entities that vary, within an ontological hierarchy, across qualitative thresholds, in their degrees of "prehensive unification." The greater the degree of prehensive unification, the more entities begin to reflect objects that we recognize as exhibiting agency, structure, consciousness, organization, and control. Processes of lesser prehensive unification account for the apparent regularities that natural science both discerns and acts upon. But regularities, in Whitehead's thought, are "habits" rather than laws. Greater prehensive unification accounts for the judging, feeling, valuing, thinking, and living self as a *teleodynamic,* creative process of becoming rather than the unfolding of a *teleological* finalism or a *teleonomic* sequence.

Let me explore these terms before going further. The term "teleology" generally refers to "subjective teleology," i.e., "intentional acts with an intentional subject" (Elster 1982). Subjective teleology can be distinguished from objective teleology ("processes guided by a purpose without an intentional subject") and teleonomy ("the quality of apparent purposefulness of structure or function in living organisms due to evolutionary adaptation" (Merriam-Webster). Elster contends that teleonomy and objective teleology are different categories, but the terms are often treated as if they are interchangeable. The Greek suffix

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positivism would not have been possible without himself. Whitehead, however, approached mathematics as a purely technical discipline in the sense that he did not objectify it like Russell or the logical positivists after him. Whitehead's own metaphysical system, which he only began to devise at age 65, is an example of speculative naturalism in the company of Schelling, Collingwood, James, Berson, Peirce, Dewey, and (Gare 2014).

[83] Note that Whitehead's philosophy features in the work of both Nicholas Georgescu-Roegen as well as that of his former student, Herman Daly. *For the Common Good*, which is broadly considered a significant text in ecological economics, was co-authored with the Whiteheadian process-theologian, John B. Cobb. In contemporary EE, Barbara Muraca applies Whitehead's philosophy in the concept of "relational values" as an alternative to instrumental values.

"-nomy" refers to "lawlike behavior, whereas "logos" refers to "divine reason." Teleonomy, thus, refers to "behavior that [is] asymmetrically oriented toward a particular target state, even in systems where there [is] no explicit representation of that state (much less an intention to achieve it) but only a regular predictable orientation toward an end state" (Deacon 2012) (For our purposes, I follow Deacon and interpret teleonomy as a form of "objective teleology"). Richard Dawkins, for example, by invoking the concept of the "selfish gene" as an expression of the "blind watchmaker" (Herbert Simon's term) affirms evolution as a distinctly teleonomic process.

The term teleodynamism, as I interpret it (because no concise definition exists) engenders the search for, interpretation, and creation of meaning by an agential, creative, and intentional subject. Teleodynamism, therefore, contains an irreducible semiological component whereby information is reflexively transformed into meaningful signs and where systems of meaning are employed by subjects in their functional responses to a dynamically shifting world. Teleodynamism is, therefore, also distinct from both homeodynamic (i.e., equilibrating) processes (e.g., thermodynamics), and morphodynamic (i.e., dynamically metastable) processes such as dissipative systems in non-equilibrium thermodynamics (see figure 9).

> teleodynamic processes are inevitably dependent on morphodynamic processes for their form generating capacity. As we've seen, morphodynamic processes are dependent on the maintenance of far- from-equilibrium thermodynamic conditions. So the dependence of teleodynamics on morphodynamics and morphodynamics on thermodynamics constitutes a three-stage nested hierarchy of modes of dynamics, which ultimately links the most basic orthograde process—the second law of thermodynamics—with the teleodynamic logic of living and mental processes (Deacon, 2012, p. 276).

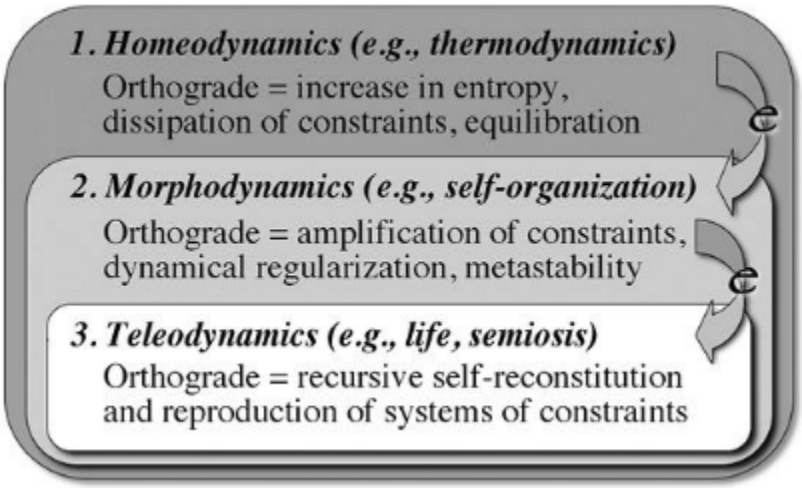

Figure 9: From Deacon, 2012, p. 270; a hierarchy of "emergent levels of dynamics". Note that a similar hierarchy can be found in Salthe's (1993) *text, Development and Evoltuion. Salthe refers to morphodynamism as teleonomy and homeodynamism as "teleo-maty". In both cases, systems of greater organization, integrateness between their components, and a higher degree of conscious awareness emerge out of "subvenient dynamical processes" lower on the specification hierarchy. Teleodynamism, thus, relies on both teleonomic and teleomatic processes to persist.*

What this establishes is that creative, agential systems go beyond, but also rely on, the sorts of teleonomic, homeo-and-morpho-dynamic processes that are the primary concern of systems ecology, complex adaptive systems, and non-equilibrium thermodynamics. It shows how life not only defies the second law of thermodynamics - insofar as a living thing represents a thermodynamically open system that maintains itself at far-from equilibrium conditions by importing high-exergy energy and exporting low-exergy energy (see Schneider & Kay, 1994, 1995; Schneider & Sagan, 2005) – but it transcends the centrifugality of non-equilibrium self-organization as well.[84] As Ulanowicz observes:

[84] Briefly, Schneider and Kay (1994) demonstrated that the non-equilibrium thermodynamic processes necessary for abiogenesis (i.e., the emergence of life from non-life) were not accidental, but rather resulted from the general tendency of non-equilibrium thermodynamic systems to progressively "resist" being pushed further away from thermodynamic equilibrium by self-organizing dissipative structures into whichever configurations would most effectively eliminate the gradient. This idea constitutes a "restated second law" that is, on it's face, not entirely dissimilar from Lotka's "maximum power" or Odum's "maximum empower". Schneider and Kay, however, explicitly reject sociobiological interpretations of their theory: "Living systems are sophisticated mini-tornados, with a memory (its DNA), whose Aristotelian "final cause" may be the second law of thermodynamics. However one should be clear not to overstate the role of thermodynamics in living processes. *The restated second law is a necessary but not a sufficient condition for life… We reject the selfish gene (Dawkins, 1976), as the only process in selection and would insert the gene or species as a component in competing autocatalytic ecosystems (Weber et al., 1989), competing to degrade available energy gradients*" (p. 15).

> Schneider and Kay [16] described the drive behind the development of living systems as a unitary statement of the two laws of thermodynamics whereby exergetic gradients are degraded as quickly as possible whenever and wherever they might appear. Common to all these propositions is the notion that the second law is the fundamental essence of universal dynamics, while apparent increases in order are accidental and subservient to the drive of the second law per se. The proposition here differs in a subtle but fundamental way from these latter suggestions, namely, as first suggested to the writer by James Kay, the prevailing view of the second law is an over- simplified version of its true nature. Simply put, entropy is not entirely about disorder. Away from equilibrium, there is an obverse and largely unappreciated side to the second law that, in certain circumstances, mandates the creation of order (Ulanowicz 2009c).

To be clear, I am employing these ideas to promote an "organic" theory of society, but it should not necessarily be interpreted as an *organicist* theory of society (see Ulanowicz, 2009a, p. 96). That is, to claim that a society constitutes a social organism, one must first assume that the organism is the ideal and normative expression of holism. Once again, this idea is not problematic in and of itself, but it becomes problematic when one adopts a distinctly mechanistic (i.e., in-organic) concept of life (e.g., in structural functionalism). Spencerian functionalism was problematic not *because* it theorized a social organism but because its concept of the organism was actually a materialist concept of the organism-as-machine. For relational holists such as Whitehead with his "Philosophy of Organism," however, the idea of a "social organism" is turned on its head because, although Whitehead attributes all relational wholes the status of organism, he does so only after having first established that organisms themselves are types of societies (whereby plants are analogous to democracies and animals are analogous to kingdoms; see (Whitehead, 1958 [1938], 1978 [1929])). Here, the concept of social organicism is disarmed of its functionalistic and social Darwinist implications because it eschews the normative assumption that evolutionary processes are contestory rather than co-constitutive and mutualistic. Connolly, following Deleueze and Guattari, who followed themselves followed Whitehead, is promoting a "Rhizomatic" image of multi-faceted democracy that evolves through co-constitute processes of “creative involution” between systems, nested systems, and the systems constituting their environments:

> Creativity is a process within which we are embedded rather than the effect of an agent, and it is even tinged by an aura of mystery. It happens within constraints. The constraints are explained in large part by the fact that at any moment in chrono-time the universe is

composed of “actual entities” of innumerable types, which help to set preconditions for new events. An actual entity is any formation that has some tendency toward self-consistency, such as a rock, a cell, a liver, a tornado, a system of ocean currents, a continent, an organism, a civilization, a mist, or a human being. Remembering that the human organism is itself composed of many interacting bodies of heterogeneous sorts—including viruses infused into organs, bacteria, and brain nodules inherited from reptiles—we can say that the creative process is lodged in the reverberations within or between entities which periodically arise, including the energized excesses that occupy and entangle them (Connolly, 2014, p. 63-64).

The word “drive” can function as a noun or a verb, or be ambiguous as in the word “arrest”. “You are under arrest; you are arrested.” The noun form thus contains a trace of the verb mode within it, as being placed under arrest speaks to a previous movement that would have continued until arrested. Same with drives: “You have a drive; it drives you.” A drive expresses movement, impulsion, pressure, even sometimes implacability. It contains more, too. Drives are not blind forces pushing forward as a billiard ball pushes another ball into a pocket. A drive, once triggered by an event, is an affect-imbued mode of perception, intentionality, and interpretation on the way. A drive’s powers of perception and intention may be simple, something like that of a spider when it aims at the fly in its web or, in a more complex and gentle instance, a humming bird when it sucks nectar from a flower. A drive may be cloudy as well, as when you are driven forward by erotic pressure but remain unsettled as to what mode of conjugation at which to aim or when we vaguely seek a new collective alliance but have little idea about what its terms might become. Here the cloudiness may be real, while the process is on the way, not merely an epistemological limitation that screens first person experience and third person observers from an object that is clear and simple in itself. The aim is consolidated on the way. Teleodynamism… The character of drive complexes helps us to see what both tactics and micropolitics work upon; it also provides clues as to how they can do their work.

Heterogeneous drives wrestle with and infiltrate each other, particularly when a new human or nonhuman event triggers a specific nest of intersecting drives. That is why they are not well understood dialectically. They periodically combine or coalesce, sometimes creating a new result out of subliminal, teleodynamic exchanges between them. The new

> result is neither the result of an aggregation of blind causes nor is it the explicit rendering of what was implicit all along; it is neither efficient cause nor holistic purpose. Sometimes a teleodynamic searching process is triggered, in which several drives adjust to each other until a result bubbles up that was not there before. The teleodynamic process promotes the possibility of real creativity in human life in a way both comparable to and more complex than how it proceeds in species evolution (Connolly, 2014, p. 66).

What does this do for us? Whitehead, for Connolly, thus, accounts for creativity, agency, and subjectivity in the human estate by distributing it to the non-human estate. In effect, a process-relational ontology satisfies what Spash hopes to gain from critical realism, but without relegating meaning, value, and feeling to exclusively human affairs (Muraca 2007; Nelson 2003). By providing an ontology of becoming with a framework of constraints (some fixed and others mobile) this perspective not only accounts for agency and structure in a non-dualistic continuum, but it also helps us to recognize how micro-affective-impulses have the capacity to interpenetrate and entrain even many macroscopic processes that they themselves fall within. The distinction between teleonomony and teleodynamism helps us to recognize the interdependencies between systems that exhibit differential capacities for self-organization, and this insight may prove instructive when we are considering how to select the appropriate responses within post-normal problem contexts. That is, Connolly, I believe, provides an ontological clue as to the meaning of "emergent complexity" that, for Funtowicz and Ravetz, constitutes the threshold between expert science and post-normal science. I will further develop this train of thought in the next chapter.

To conclude this section, however, we must also reflect on what Connolly's account does *not* do for us. As his critics point out, Connolly does not define complexity, nor does he provide the means for differentiating between differential degrees of self-organization such as teleonomy and teleodynamism. Deacon, similarly, provides less instruction on this point than one might imagine. Neither thinker defines what complexity means, and although they both explain how teleonomy and teleodynamism differ, they do not explain *why*, and that oversight presents a problem if I am going to attempt to use this ontopolitical orientation to sublimate the epistemological violence that has marred previous attempts at bringing sustainability science and environmental justice into a pluralistic dialogue. Addressing this deficiency is no easy task, particularly because Connolly does not venture very far *into* the systems discourse itself, where a wide variety of definitions and interpretations of complexity proliferate. Here is where I believe I can supplement Connolly's politics of complexity by using his onto-political approach to genealogy to find corresponding concepts within the broader archive of systems and cybernetics. In

doing so, it will also be necessary to interrogate and deconstruct critical accounts that, through misinterpretation and mis-association, often further complicate the potential for meaningful engagement between systems and social theory. This final passage by Connolly will provide the clues that will be useful for orienting this final stage in my investigation:

> There are simple and complex versions of self- organization, as we shall see. The most complex version is perhaps best described as having a "teleo-dynamic" element in it: it exceeds blind causality without being tethered either to simple intentionalism or to ontological finalism. A cosmos composed of innumerable, interacting temporal force fields with varying degrees of self- organizational capacity subtracts from it both finalism and the sufficiency of blind, efficient cause. The sufficiency of simple intentionality bites the dust too. There are efficient causes, but they do not suffice to explain the most critical events. That is because in some of these events a creative result emerges out of the conjunctions between blindness and self- organizational processes.
>
> A process of self- organization can be marked and identified in specific cases; it can even be experimentally induced and observed on occasion, as we shall see. But the process does not conform neatly to any model of classical explanation. The imputation of differential capacities of self- organization to heterogeneous processes may help us to grasp, up to a point, an element of real uncertainty and real creativity that periodically courses through processes and beings. A residue of mystery may still cling to our understanding of self-organization, however. At least, there is no cosmic guarantee that the puny human estate will someday grasp fully everything that happens or even elaborate a framework sufficiently capable of doing so in principle. The more you identify an element of real creativity in human life, in some nonhuman processes, and in the relations between them, the more such a suspicion grows. *For the reality of creativity and the demands of complete explanation do no mesh together neatly* (Connolly, 2013, p. 8-9).

As we will see, the fact that incompleteness and creativity do not mesh together belies the fact that they are intrinsically entangled. I maintain that the key to understanding complexity is understanding why that is.

Chapter 5: The Complexity of Difference

We live in a partially ordered world where stability is earned over creative processes, where stability never has the last word – Michel Weber (2009, p. 121).

5.1: Differentiating the Systems Chimera

Complexity is among the most used yet rarely defined and often misunderstood terms one will ever encounter. Like resilience, complexity is polysemic, and all of the different definitions of complexity lend themselves to distinctly different ontopolitical interpretations. This creates a problem for Connolly's politics of complexity because he, like many others, does not specifically define what concept of complexity he is invoking or endorsing. Furthermore, with only a few exceptions (e.g., Stuart Kauffman or Ilya Prigogine), Connolly does not "name names," nor does he clearly indicate which interpretations of complexity he disavows. However, the philosophers that he *does* endorse in articulating his ontology provide ample clues for those who are familiar with the many disparate strands of systems discourse. So, whereas Chapter 4 looked at what Connolly's approach can do to extend sustainability science, this chapter approaches the problem from the other angle, where I am examining the ways in which complexity can further environmental justice by meeting Connolly in the middle. To do that, however, it is once again necessary to examine how genealogists have investigated complexity in the past.

Walker, in his text, *More Heat than Life*, which is a lengthy critique of ecological economics, points to the following passage by Abel and Steppe as a point of reference for his critique of contemporary complexity theory:

> … what actually constitutes complex systems science is not yet settled. Although there are many threads, we and others … see an integrated, evolutionary science of complex systems emerging from the synergy between new computational paradigms (chaos theory, agent-based modelling, and self-organization), dramatic breakthroughs in the venerated field of non- equilibrium thermodynamics, empirical research into large, complicated systems such as weather, earth systems, and ecosystems, and innovation in evolutionary theory. … As an emerging field, some researchers claim their part as the whole, but we prefer to see the

> connections and the possibilities of an open, multi-disciplinary, evolutionary, and integrative systems science (Abel & Stepp, 2003; quoted in Walker, 2020, p. 314).

This statement, and the fact that Walker is so eager to accept it, underscores not only the importance of conducting genealogical investigations into systems theory, but also the importance of interrogating the genealogists as well (and I sincerely submit my own prejudices for such review). Abel and Stepp's "evolutionary science of complex systems" along with the conventional interpretation of complexity that it engenders are both "chimeras" in Foucault's terminology. That is, conventionalized complexity is a discursive object that is held together by implicit and covert "facile gestures" that hold ideas together that are not necessarily otherwise related. Rather than accepting these gestures (as Walker and Cooper do), the genealogists task is to disassemble the chimera by interrogating the discursive practices that hold them together. Following Connolly's onto-political approach, my task is, therefore, to examine how the ontologies between the constituent elements of a "science of complexity" differ, and how their onto-political interpretations differ as well. The first step in doing so is to examine Abel and Steppe's claim that it is possible to integrate the constituent fields of "complex systems science."

Despite apparent similarities, there are significant ontological discrepancies between chaos theory (i.e., non-linear dynamics), cellular automata (i.e., complex adaptive systems)[85] and self-organization (i.e., open systems theory and non-equilibrium thermodynamics). Philosophically, these fields do not belong together, but they are held together by discursive practices, "facile gestures", of the sort exhibited by Abel and Stepp and then casually accepted by Walker and Cooper. Very briefly, the fields of non-linear dynamics (chaos theory) and complex adaptive systems both accept ontological determinism, whereas open systems theory represents quite possibly the strongest scientific evidence we have *against* ontological determinism. Chaos theory, by contrast, accounts for uncertainty as a result of the impossibility (due to the observer problem in quantum mechanics) of knowing with certainty the precise starting conditions of any systems at any point in time. Chaos in non-linear dynamics is "deterministic chaos," whereas "chaos", in Prigogine's terminology, allows for ontological aleatory, the idea that our reality is shot through with causal holes, where genuinely random events can and do happen.

> How will the system choose between left and right? There is an irreducible random element; the macroscopic equation cannot predict the path the system will take. Turning to a microscopic description will not help. There is also no distinction between left and right.

[85] There is a great deal of research on complex adaptive systems that does not use cellular autonomata, but it must be understood that cellular automata is the method that underwrites the field.

> We are faced with chance events very similar to the fall of dice (Prigogine & Stengers, 1985, p. 162).

Prigogine demonstrated that bifurcations in non-equilibrium systems are unpredictable with either classical physics or statistical mechanics. His allusion to the "fall of dice" is an answer to Einstein's assertion that "God does not play dice." Prigogine demonstrated that random events do, in fact, occur in non-equilibrium systems, and the implications of this discovery are general because the very concept of an isolated system is abstract. All thermodynamic systems that humans *actually* interact with are open systems.

By the same token, complex adaptive systems claims an affinity with self-organization theory,

> It is difficult to underestimate the importance of the distinction between the deterministic ontology of chaos and the understanding of emergent causality of complexity theory. Calculation or control and direction become impossible in complexity theory, but the unknowable is not a result of hidden determinism (as in chaos theory), nor can it be the result of blind chance or luck… Complexity has a different ontology to chaos theory, which drew on theoretical developments in quantum mechanics. Complexity's roots are in the laws of thermodynamics, evolutionary science and computational mathematics (Chandler, 2018, p. 25).

Here, Chandler, a proponent of resilience theory, goes beyond Abel and Stepp by casting out Chaos Theory and defining "complexity theory" as the synergy between complex adaptive systems and non-equilibrium thermodynamics. Once again, however, this is a case of the genealogist embracing the Chimera. That is, Chandler attempts to connect the ontology complex adaptive systems to that of non-equilibrium thermodynamics by simply asserting that "Complexity's roots are in the laws of thermodynamics, evolutionary science and computational mathematics", but he does so without questioning whether non-equilibrium thermodynamics, evolutionary science, and computational mathematics ought to go together. In fact, if we examine the most notable theorists and methodologists in the complex adaptive systems tradition (namely Simon Levin and Murray Gell-Mann), one will notice that both seem to indicate a distinctly nomothetic and positivist orientation to evolutionary theory that mirrors the deterministic-evolutionary ontology of Von Neumann that served as a pretense for his cellular automata in the first place. For example, according to Levin, one of the essential features of a complex adaptive system is that it will evolve in accordance with "An autonomous process (such as

natural selection) that uses the outcomes of … local interactions to select a subset of … components for replication or enhancement" (Levin 1999). In and of itself, such a statement only indicates Darwinian evolutionary theory, which can be interpreted in light of many ontological orientations, and does not necessarily suggest that the evolutionary process is likable to a mechanistic-algorithmic process. On the other hand, however, complex adaptive systems theorists have a tendency to conflate mathematical models with actual biophysical processes such that it is difficult to discern whether they are putting the methodological cart before the ontological horse. Note, for example, the apparent affinity between thermodynamics and complex adaptive systems is predicated on an analogy of "computational equivalence" between cellular automata and the second law.

> "In principle, reversibility is possible, analogous to Poincaré's famous theorem of reversibility in statistical mechanics, but extremely improbable. By starting with a simple state and tracing the actual evolution, one can find initial conditions that will lead toward to decreasing randomness …. But for cellular automata, the computational amount to go backwards and find these conditions cannot be reduced to the actual evolution from simple to random patterns: Computational irreducibility corresponds to temporal irreducibility and improbability. Thus, in computer experiments with cellular automata, we get a computational equivalence of the 2nd law of thermodynamics…
>
> Different increasingly complex and random patterns can be generated by the same simple rules of cellular automata with different initial conditions. In many cases, there is no finite program to forecast the development of complex and random patterns. The algorithmic complexity … is incompressible due to its computational irreducibility. In this case, the question of how the system will behave in the future is undecidable, because there can be no finite computation that will decide it. Obviously, computational irreducibility is connected to Turing's fundamental problem of undecidability. Whether a pattern of a cellular automaton ever dies out can be considered analogous to the halting problem of Turing machines (Mainzer, 1997, p. 224-225).

In cellular autonoma, then, we have familiar elements of unidirectionality, uncertainty, and incompleteness, but not the ontological indeterminacy that one finds in the process-relational philosophy of Prigogine (whom, it must be said, was greatly assisted by his co-author, the philosopher of Science, Isabelle Stengers). It may not be possible to predict from the starting conditions what a simulation of cellular automata will do, and it is similarly not possible to work one's way backward from

the end state of a simulation once it is run (hence the analogy to entropy), but the fact remains that given the starting conditions, the simulation will do exactly the same thing every time it is run. Computers, by definition, are incapable of truly random, let alone teleodynamic, behaviour. Prigogine militated against all biophysical determinism, including the idea that life represented, or could be represented by automata.

> After all we have to find what I like to call "a narrow passage". A world of determinism is an alienating world. What is our place in a world of automata? Here we cannot conceive that the meeting we have had today has been pre-determined as a big bang, that is very difficult to imagine. A world of accidents, a world in which we would play dice is also not a world in which we can live. My aim has been to find a narrow passage between this deterministic world and a completely undeterministic world, and perhaps one of the attempts which I've tried to make is essentially to formalize this world in between, not the world of determinism and not the world of the future (Prigogine as quoted in Guerra, 1996, p. 492).

For the social ecologist Murray Bookchin, the anti-mechanistic implications of non-equilibrium thermodynamics did not go far enough because they did not affirm the "internal developmental logic" of non-equilibrium systems[86], but more recent scholarship in social ecology recognizes that Prigoginean self-organization actually provides strong *support* for the sort of dialectical ontogenesis that Bookchin himself endorses. Prigogine, in other words, opened the door for teleodynamism in the hopes that we would one day cross that threshold (the "narrow passage" between determinism and aleatory), but he did not cross it himself. This is why Prigogine occupies a unique position in the contentious ground between, and overlapping, both sustainability science and environmental justice; his findings support both holistic and anti-mechanistic orientations. For proponents of the highly prevalent mechanistic-computational systems approaches (e.g., cellular automata or systems dynamics), association with Prigogine vis-à-vis analogy provides a desirable counterpoint to their anti-mechanistic critics.

Kuhn (Kuhn 1962) observed that scientists are conservative, and it is generally understandable why it is necessary for them to be so even as scientific paradigms begin to drift further afield from observable

[86] From Bookchin: "Prigoginian systems theory [does not] allow for a concept of potentiality: it is rather chance and stochastic phenomena that act as "mediating" phases between one "dissipative structure" and another. Confronted with "far from equilibrium" disorder and succeeding orderly systems, speculative thought is reduced to mere observation. Indeed, a system approaching transition may not assume an immanently predictable form thereafter — it may simply fall apart into "chaos." These systems have, in effect, no internal developmental logic" (Bookchin, 1995, p. 112).

reality. Philosophy, by comparison, has the potential to change much more rapidly, and, following Easlea, generally, when the two move in lock-step, it is because they are being used in tandem to consolidate and naturalize a particular regime of political power. In Kuhnian terms, then, I argue that we ought not to think of either systems theory in general (encompassing any of the constituent "strands" of systems theory) as constituting a "new paradigm" characterized by a nomothetic "science of complexity," but we might instead consider the systems discourse itself as exemplary of "paradigm drift" whereby scientists, recognizing the inconsistencies of a current paradigm, envision new potentials despite possessing neither the tools nor the social licence to overturn the old worldview. With limited tools and tactics and with an interest in revealing the shortcomings of the current paradigm, scientists amplify the current inconsistencies vis-à-vis the only means at their disposal - the tools of the paradigm they are subtly working their way out of. Wiener, for example, is remembered as an arch-mechanist (Galison 1994) despite his philosophy having firmly embraced both hylozoism and the doctrine of internal relations (i.e., Leibniz as the "patron saint" of cybernetics). Wiener, by associating teleology with servomechanism (i.e., purposive machines) *leaned into* the machinist paradigm to indirectly *resuscitate* concepts of purpose and agency that had been suppressed under the mechanistic paradigm.

> … Wiener did not intend to dismantle the liberal humanist subject. He was less interested in seeing humans as machines than he was in fashioning human and machine alike in the image of an autonomous, self-directed individual. In aligning cybernetics with liberal humanism, he was following a strain of thought that, since the Enlightenment, had argued that human beings could be trusted with freedom because they and the social structures they devised operated as self-regulating mechanisms. For Wiener, cybernetics was a means to extend liberal humanism, not subvert it. The point was less to show that man was a machine than to demonstrate that a machine could function like a man (Hayles, 1999, p. 7).

In systems theory, then, we see examples of micro-political acts of subversion, and we also see the opposite; the conservative scientific impulse not only to sequester but also to sublimate or reintegrate subversive ideas back within the hegemonic fold. Sometimes opposing impulses by different thinkers within a common tradition, or in the subtle disparities between the epistemological assumptions of teachers and their students (Forrester and Meadows), or within the same thinker at different stages in the development of their thought (e.g., Ashby, von Foerster or Stafford Beer). As we have seen, there is a wide variety of both metaphysical commitments and political ideologies. Some systems theorists, such

as Herbert Simon, explicitly rejected metaphysics but viewed holistic approaches as a matter of pragmatic necessity:

> Roughly, by a complex system I mean one made up of a large number of parts that interact in a nonsimple way. In such systems, the whole is more than the sum of the parts, not in an ultimate, metaphysical sense, but in the important pragmatic sense that, given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole. In the face of complexity, an in-principle reductionist may be at the same time a pragmatic holist (Simon, 1962, 462).

Von Neumann, unlike Wiener, very much sought to fashion the "human and machine alike in the image of an autonomous, self-directed individual," and, for many, his legacy in complex adaptive systems suggests that we are moving backward from the threshold opened by Prigogine by accepting once again that the keys to understanding life are held firmly the grasp of mechanistic, teleonomic automata. But the Corollary to Simon's argument is that in-principle holists can also be "pragmatic reductionists," and this severely complicates Connolly's proposition that we can always infer implicit ontological commitments from methodological procedures of systems theory. Mathematical modellers can, in principle, affirm relational, indeterminate metaphysics whilst entirely aware of the impossibility of representing such an ontology within the deterministic universe of computer simulation. "All models are wrong, but some are useful" after all (Box 1976, 1978), but a follow-up to this familiar aphorism should always be to ask, "How do we tell the difference?" and a second follow-up would be, "who is the model useful for?". The answers are not always clear, particularly when we are modelling teleodynamic agents with teleonomic automata. For Connolly and Machin, a key characteristic of authoritarian systems of governance is an attempt to superimpose the logic of teleonomy over teleodynamic systems, thereby displacing politics. Following Wiener, "the best material model for a cat is another, or preferably the same, cat." But insofar as we are interested in predicting what cats will do under various circumstances, we must unavoidably compress, and thereby distort, what it means to be a cat. The same behaviorism applied to humans is distinctly dehumanizing; it is anti-humanism. And so pragmatic reductionism, like complementary, provides only a temporary reprieve from complexity, and it provides a feeble defense against illiberalism.

Nevertheless, as I have argued, I believe it is bad tactics to implicate systems theorists in the reductionist paradigms that many of them resisted in their own ways and on their own terms. If critics object to neo-liberalism, and if neo-liberalism objectifies complex adaptive systems research, then ought we to then

problematize complex adaptive systems by association? By the same token, if complex adaptive systems researchers claim Prigogine, then ought we to problematize Prigogine as well? Doing so, I contend, is self-defeating because it engenders conceding those ideas to the very hegemon who desires them as a source of validity. Following Connolly, I maintain that it is better tactics to operate with a sense of "presumptive generosity"; to recognize and accentuate the subversive impulses nascent in systems concepts and put them to use in the pursuit of more generative, pluralistic potentials. To do this, I argue it is necessary to first identify and disrupt the discursive practices that anti-pluralists employ to fold these concepts into their naturalizing narratives.

How do we tell the difference between subversive and conservative impulses – between "pragmatic holists" and "pragmatic reductionists" - particularly when they employ the same concepts, methods, and language? This question, I will argue, is entangled with other questions: how ought we to know when we have crossed the threshold between expert science and postnormal science (where "emergent" complexity has dominion)? What is the difference between "thick" and "thin" complexity? Where is the threshold between agonistic political contestation and antagonistic extremism? Following Connolly, I agree that key insights into all of these questions can be gleaned from the distinction between teleonomy and teleodynamism. It behooves us then to pursue a more operational definition of teleodynamism than the one Deacon provides, and I will argue that such a definition can be found in neglected corners of systems theory itself. To do this, I will interrogate what I call "conventionalized complexity" (Zellmer et al. 2006) as a discursive object that fuzzies the distinction between teleonomy and teleodynamism. A prime example of what I consider to be "conventionalized complexity" is contained in the following passage by Berkes et al.:

> A complex system can be distinguished from one that is simple – one that can be adequately captured using a single perspective and a standard analytical model, as in Newtonian mechanics and gas laws. By contrast, a complex system often has a number of attributes not observed in simple systems, including nonlinearity, uncertainty, emergence, scale, and self-organization.
>
> Nonlinearity is related to inherent uncertainty. Mathematical solutions to nonlinear equations do not give simple numerical answers but instead produce a large collection of values for the variables that satisfy an equation. The solutions produce not one simple equilibrium but many equilibria, sometimes referred to as stable states or stability domains, each of which may have their own threshold effects (Scheffer et al., 2001). Complex

systems organize around one of several possible equilibrium states or attractors. When conditions change, the system's feedback loops tend to maintain its current state – up to a point. At a certain level of change in conditions (threshold), the system can change very rapidly and even catastrophically (called a flip). Just when such a flip may occur, and the state into which the system will change, are rarely predictable. If so, Holling (1986) pointed out, phenomena such as climate change would hardly be expected to proceed smoothly and predictably, and he drew attention to a system's resilience as a critical factor in environmental management. Resilience may be considered an emergent property of a system, one that cannot be predicted or understood simply by examining the system's parts. Resilience absorbs change and provides the capacity to adapt to change, as defined later and as illustrated in several chapters of this volume.

Scale is important in dealing with complex systems. A complex system is one in which many subsystems can be discerned. Many complex systems are hierarchic – each subsystem is nested in a larger subsystem, and so on (Allen and Starr, 1982). For example, a small watershed may be considered an ecosystem, but it is part of a larger watershed that can also be considered an ecosystem and a larger one that encompasses all the smaller watersheds. Similarly, institutions may be considered hierarchically, as a nested set of systems from the local level, through regional and national, to the international. Phenomena at each level of the scale tend to have their own emergent properties, and different levels may be coupled through feedback relationships (Gunderson and Holling, 2002). Therefore, complex systems should be analyzed or managed simultaneously at different scales. Consider, for example, biodiversity conservation. Problems and solutions of conservation at the genetic level are considerably different from those at the species level or the landscape level. Different groups of conservationists focus on different levels; they may use different research approaches and may recommend different policies. Biodiversity can be considered at different levels of the scale. However, because there are strong feedbacks among the genetic, species, and landscape levels, there is coupling between different levels, and the system should be analyzed simultaneously across scale.

Self-organization is one of the defining properties of complex systems. The basic idea is that open systems will reorganize at critical points of instability. Holling's adaptive renewal cycle, discussed later in the section on resilience, is an illustration of reorganization that

> takes place within cycles of growth and renewal. The self-organization principle, operationalized through feedback mechanisms, applies to many biological systems, social systems and even to mixtures of simple chemicals. High-speed computers and nonlinear mathematical techniques help simulate self-organization by yielding complex results and yet strangely ordered effects. For example, for many complex systems such as genes, Kauffman (1993) argues that spontaneous self-organization is not random but tends to converge towards a relatively small number of patterns or attractors. At each point at which new organization emerges, the system may branch off into one of a number of possible states. The direction of self-organization will depend on such things as the system's history; it is path dependent and difficult to predict (Berkes et al., 2002, p. 5-7).

This passage represents conventionalized complexity because it describes what complexity does without explaining why systems are complex. There is, in other words, no integrated and consistent theory of complexity that connects each of these "characteristics" of complex systems together. In addressing this, I am not criticizing the authors since it is clear that this distinction is not germane within the context of the argument they are making. The distinction is, however, significant from the onto-political perspective because the "characteristics" of complex systems are all based on insights drawn from different sources, and those insights were grounded in distinctly different ontological commitments and epistemological assumptions. From this description alone, we cannot know whether we are dealing with pragmatic holists or pragmatic reductionists, and so it is unclear where the authors are discussing complexity in terms of ontology or epistemology. For example, as discussed in Chapter 2, a system may exhibit "uncertainty" for any number of reasons. It may be uncertain because it is indeterminate, and it may be indeterminate because it involves ontologically random events. On the other hand, the system may be indeterminate because it involves purposive, teleodynamic agents with changing perspectives and goals. Another possibility, following chaos theory, is that the system is deterministic, and uncertainty stems from our inability to precisely measure its starting conditions. Moving on to the concept of emergence, we might ask "why" a system is "more than the sum of its parts". Is some undetectable ontological phenomenon occurring that makes it so? Or are our models incapable of explaining what it occurring when the elements combine? As Simon intoned above, the concept of emergence in and of itself makes affordances for either pragmatic reductionism or pragmatic holism. What about scale? Are we dealing with nested, autopoietic, "Janus-faced holons" such as those described in Koestler's *The Ghost in the Machine* (1968), or, instead, is scale a matter of the perspective

of the observer and the choices the observer makes in subjectively placing boundaries around the phenomena they are observing (Allen and Ahl 1996)[87]?

Conventionalized complexity muddles the distinction between ontological commitments and epistemological assumptions and, thereby, also muddles the distinction between teleonomy and teleodynamism. When the authors suggest that complex systems are not adequately describable within any one analytical model, they do not tell us *why*. Once again, there are many possible answers to that question, and it matters which one you choose. The first thing to note about this passage is that the five "characteristics" of complex systems are all attributed to reputable sources, but the preceding statement, however, that provides the distinction between simple and complex systems is not attributed to anyone; it is simply provided as a self-evident truism. Within teleonomic systems approaches, the concept of "multiple perspectives" remains fuzzy, but it is generally described in terms of alternate selections of control variables within the same analytical framework. This approach affirms "multiple perspectives" up to a certain point but still reifies the ontology implicit within the pre-analytical assumptions of the modelling framework itself. For example, it is possible for different system dynamics models to describe the same system with different suites of variables depending on different perspectives, but the broader perspective is one that affirms the system as something that is, in principle, describable in terms of stocks, flows, and ordinary difference equations. The same restriction applies to cellular automata or any other modelling methodology. The very idea of "multiple non-equivalent perspectives" precludes the possibility of devising a unified, nomothetic theory of complex systems in which all of their characteristics can be known. Thus, the first statement that Berkes et al. make in attempting to explain complexity - i.e., that a complex system cannot be understood from any one descriptive mode to the exclusion of all others - is also the most important statement because it precludes both the possibility of misusing systems theory to support deterministic theories-of-everything, and it also protects systems theory by deflecting claims that systems scientists are attempting to promote such an idea. The fact then that this statement is not referenced (and this is very often the case) is significant and needs to be addressed.

[87] Berkes et al. cite Allen and Starr to make describe the "characteristic" of scale in complex systems, and this is significant because Allen's position has shifted over the years. Although Allen's later writings on hierarchy theory are explicitly ontologically agnostic (suggesting a purely epistemological understanding of hierarchy) his position was not yet established in Allen and Starr's 1982 text. Indeed, in Zellmer et al., Allen actually recants on his earlier, ontological interpretations of hierarchy.

5.2: Robert Rosen: Relational Biology and Incompleteness

This section will discuss the mid-20th century relational biologist Robert Rosen, whom I first introduced briefly in Chapter 2 of this text. By way of foreshadowing, there are three key points that I would like to address regarding Rosen and why he is critical to my discussion:

1. Rosen was the progenitor of the idea that complex systems engender multiple perspectives. That is not to say that he was the only systems theorist who subscribed to perspectivism, constructivism or other forms of epistemological fallibilism, but only that he was the only systems theorist to explicitly *define* complexity in terms of multiple perspectives in addition to offering an explanation supporting that argument. Rosennean complexity, I will argue, is quintessentially "thick".
2. Rosen's distinction between mechanism and organism bears a striking resemblance to Deacon's distinction between teleonomy and teleodynamism. For Rosen, life is distinct from machines in that it is anticipatory, reflexive, and, therefore, teleodynamic. Thus, Rosen, by way of Deacon, has relevance for Connolly and radical democracy.
3. Rosen's theories were both more general and more specific than Maturana and Valera's theory of autopoiesis (Poli 2010b). Rosen, however, although profoundly influential among systems theorists, never achieved the level of recognition that many of his peers enjoyed. Consequently, the subtle differences between Rosen's theory and autopoiesis were never discussed when autopoiesis was gaining popularity in social theory.

Rosen was interested in anticipatory (i.e., teleodynamic) systems because he was interested in distinguishing living things from machines (or, more precisely, "mechanisms"). Ultimately, Rosen contributed two insights into this question: first, that life is "anticipatory," and second, life is closed to efficient causation. I'll discuss anticipation first.

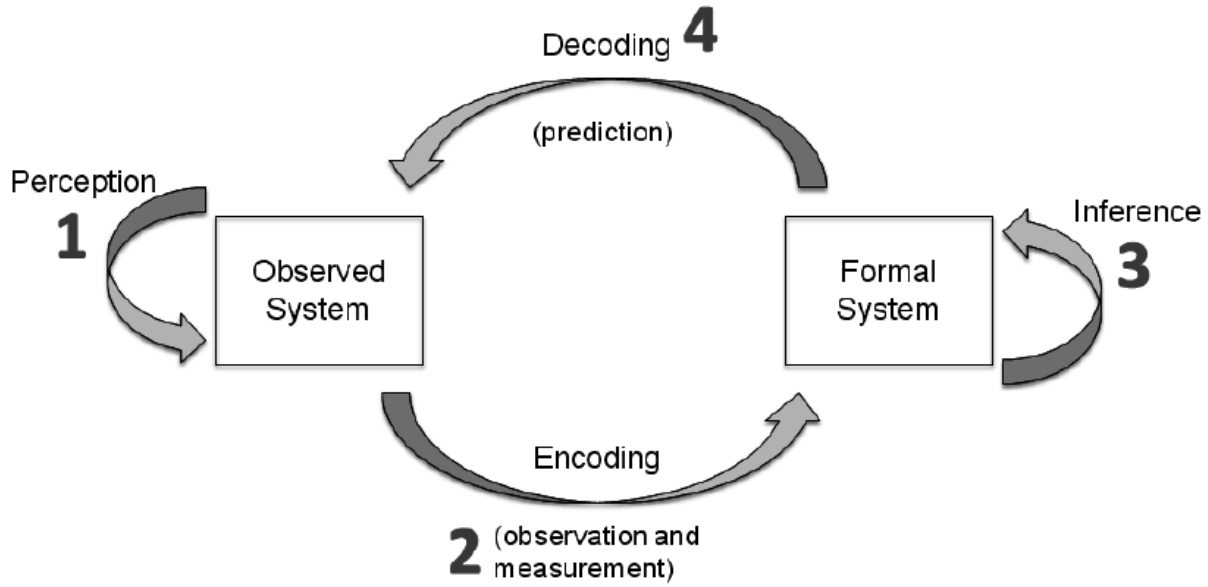

Figure 10:Rosen's Modelling relation.

In order to feed forward information, anticipatory systems must rely on formal systems of inference (i.e., models) that necessarily compress the raw data of reality so the projection can run faster than in real time. For Rosen, all models constitute a relation between two different classes of systems: natural systems and formal systems. Natural systems consist of percepts of one's environment that are subject to changes in state; they are, very simply, things in the world that an observer might imagine go together. Note that this is an extremely flexible and essentially epistemological definition for the term, "system". Natural systems are "natural" because are governed by natural entailment (i.e., natural laws, habits, propensities of however else one wishes to conceptualize regularity in nature). Formal systems, on the other hand, are logical systems that are governed by *inferential* entailment (i.e., systems of inference based on if-then propositions). To construct a formal system, one must encode one's observations of a natural system's systems dynamics into formal categories by subjectively identifying the systems relevant components and then theorizing as to how those components act one another. The model is tested against the world it is meant to represent through decoding. Rosen noted that the encoding process is undecidable and, therefore, "unentailed" within either natural or formal systems; there is no "rote" way to either encode or decode one's model. Modelling is, therefore, according to Rosen, an unavoidably creative, artful, and semiological process. In other words, he process of encoding necessarily engenders semantics (i.e., by subjectively defining the meaningful and relevant attributes of

the system) as well as syntax (hypothesizing and testing the formal production rules used to represent how the components act on one another). A ”system” for Rosen, thus, exists in the mind of the modeller and is, therefore, subject to the limits of epistemology. This point can be read in two related registers: mathematical and thermodynamic. In thermodynamic terms, natural systems are “open,” whereas formal systems are closed by definition (see Figure 11; also see Rosen, 1991a, p. 553-554). As discussed, an open thermodynamic system is subject to greater degrees of freedom than any closed system of inference that can be used to describe it. In mathematical terms, the modelling enterprise is limited due to Gödelian incompleteness; i.e., a mathematical, and therefore logical, system, so long as it is consistent, must also be incomplete due to the problem of self-reference (i.e., Bertrand Russell’s “vicious circles” that earlier plagued logical positivists). In essence, this means that no one model can adequately capture all phenomena within a single system of inference.

> We are going to define a complex system as one with which we can interact effectively in many different kinds of ways, each requiring a different mode of system description (Rosen, 1975, p. 229).

By defining complexity in such terms, Rosen effectively aligned the concept of complexity within a much broader rebuke of the possibility of the unification of science in accordance with a correspondence theory of truth. Within the broader discussion of this text, this claim has significant implications for the relationship between social theory and natural science. Consider this passage by Bateson:

> Central to the fear and dislike which the humanists express when they meet with the formulae of the scientists is the idea that the latter will assert that some hypothesis is final and complete. The humanist believes that any such final and comprehensive statement would be the destruction of his value system and would finally and irreversibly reduce the patient to an object of manipulation. It would surely do so—but the scientist today knows that no such hypothesis can be constructed without leading to contradiction or to infinite retrogression. Göedel's discovery that no system of propositions can be complete in itself and not lead to contradiction may be interpreted to mean that *Achilles can never catch the tortoise in the race which we are discussing*. The theorist can only build his theories about what the practitioner was doing yesterday. Tomorrow the practitioner will be doing something different because of these very theories (Bateson 1951).

I quote Bateson here rather than Rosen to underscore the point that, despite Rosen's novel interpretation, he did not invent this insight[88]. The idea that incompleteness constituted a firm epistemological limit with significant consequences beyond mathematics was well known since the very day Gödel proposed it. Incompleteness represented a strong rebuke against Bertrand Russell's theory of logical types as well the logical positivists who believed these ideas would grant them the ability reconcile science and philosophy (and finally put an end to metaphysics once and for all). There is a hint of Kant in Gödel insofar as it is not possible to know "things in themselves". There are elements of Plato, Schelling, Peirce, Dewey, Chang Tsu, Whitehead, Derrida, Feyerabend, Marcuse and many others in this argument. Furthermore, it is important to recognize that many systems theorists from separate traditions all affirmed different expressions of fallibilism and constructivism (Bertalanffy, for example, espoused Nietzschean "perspectivism"). Although I cannot discuss all of these thinkers (nor the ones I failed to mention by name), I will, at the very least, acknowledge that I am aware that this argument can be (and has been) approached by many different angles. The point here is not to valorize Rosen or insist that he should be recognized (although I do think he should be) but rather to establish that *Rosen was the first and only systems theorist* to *explicitly define <u>complexity</u> in terms of a plurality of non-equivalent perspectives engendered by Gödelian incompleteness.* The point is to demonstrate that Rosen provided a unique and significant perspective among systems theorists and that the systems discourse is compromised – in terms of its limited capacity to engage with other discourses - by the suppression of that perspective.

What Follows is a series of quotes that contain different expressions of Rosen's definition of complexity as well as various interpolations of that definition by several of his most notable proponents:

From *Complexity as a system property* (1975):

> For our purposes, we will call a system complex if we can interact with it in many diverse ways, each requiring a different mode of system description. Conversely, a system is called simple if we can interact with it in only a few ways, or in ways which require only a single mode of system description. Thus in particular, complexity is not an intrinsic property of a

[88] Those familiar with Bateson will also recognize many parallels with Rosen's anticipatory systems theory (see Kineman, 2007).

> system but is rather a property of our capacity to interact with it. Any particular mode of complex activity, however, can be regarded as if it were a simple system (Rosen, 1975, p.2).

From *Some epistemological issues in physics and biology* (1987):

> I would like to suggest that the class of material systems which can be described in this way is in fact a limited class, which I have called the class of simple systems, or mechanisms. Thus, in this language, a simple system is one to which a notion of state can be assigned once and for all; or more generally, one in which the Aristotelian causal categories can be independently segregated from one another. Any system for which such a description cannot be provided I will call complex. Thus, in a complex system, the causal categories become intertwined, in such a way that no dualistic language of states plus dynamical laws can completely describe it. Complex systems must then possess mathematical images different from, and irreducible to, the generalized dynamical systems which have been considered universal (Rosen, 1987, p. 324).

From *The Epistemology of Complexity* (1988):

> It is implicit in the Newtonian mode of analysis that for every natural system there exists a 'biggest', universal model, from which all others can be generated by purely formal means. This universal model must therefore contain every shred of material reality embodied in the system. In mathematical terms, it is like a free structure in the set of all models of the system; every other model is essentially a quotient of this free structure. Above all, it is a model of the same type as all the others, and above all, it is purely syntactic in nature. It is the ultimate goal of Newtonian science to construct this free universal model, which makes every other model superfluous and redundant. All of this can be summed up, and systematized, in the following way: A natural system is simple if every model of it can be simulated on a mathematical machine. And the upshot of the entire Newtonian epistemology can then be distilled into a very simple assertion about the material world: Every natural system is simple … The considerations developed above suggest that the natural world cannot be completely syntacticized, any more than the formal world can. Complexity in our sense means precisely that there is an essential semantic component to material reality which cannot be ignored. Stated another way: Purely syntactic models of material nature are too impoverished in entailment to mirror the causal sequences which

> can occur in nature, just as they are too impoverished to encompass all of natural language, or even of Number Theory (Rosen, 1988, p. 22-23).

From Donald Mickulecky (2006), who was among Rosen's most strident proponents and colleagues:

> "A system is simple if all of its models are simulable. A system that is not simple, and that accordingly must have a nonsimulable model, is complex (Rosen, 2000, p. 292).
>
> Complexity is the property of a real world system that is manifest in the inability of any one formalism being adequate to capture all its properties. It requires that we find distinctly different ways of interacting with systems. Distinctly different in the sense that when we make successful models, the formal systems needed to describe each distinct aspect are NOT derivable from each other (Mikulecky 2006).

From Zellmer et al.2006):

> Complexity is the ultimate semantic argument. If one has a paradigm, then the system is simple; perhaps complicated … but still simple rather than complex. If one does not have a paradigm for it, then the system is complex. Paradigms are essential for science, and are in a sense the end product of it. They inform scientists as to how to look at the world in a way that has currency and relevance. Complexity, then, arises when there is no paradigm, when critical decisions are left unmade. The properties that are generally under- stood by lay and many expert investigators as leading to complexity come from asserting coherent intellectual and operational frame of reference in a paradigm. Paradigms are normative frameworks that are a requirement for orderly development of scientific thought. Being the very antithesis of a paradigm, complexity cannot be understood without reference to normative values, whereupon the complexity is lost to us (Zellmer et al. 2006).

As Zellmer et al. point out, these definitions do not rely in any way on the concept of non-linearity, and, in fact, Rosen explicitly notes that dynamical descriptions of systems – which are easily simulated using computer software - are *simple* rather than complex. Why then is this definition of complexity confused and entangled with conventionalized complexity as non-linearity? To understand this, we need to look at the second core component of Rosen's theory: causal closure as impredicativity.

For Rosen, life is anticipatory because, following Prigogine and Bertlanffy, living things are open systems that must secure energy and materials within a dynamic and changing environment. For Rosen, then, the physics of complexity are those of Prigogine and Schrodinger. In Aristotle's terms, life is open with respect to material causation. It is closed, however, with respect to efficient causation insofar as life reproduces and repairs its functional and relational components. An organism is impredicative because its functional components (metabolism and repair; figure 12) cannot be fractionated - they are self-referential – and this is further why a living system is "more than the sum of its parts." Through these arguments, Rosen subtly melds the concept of complexity with the concept of "life itself."

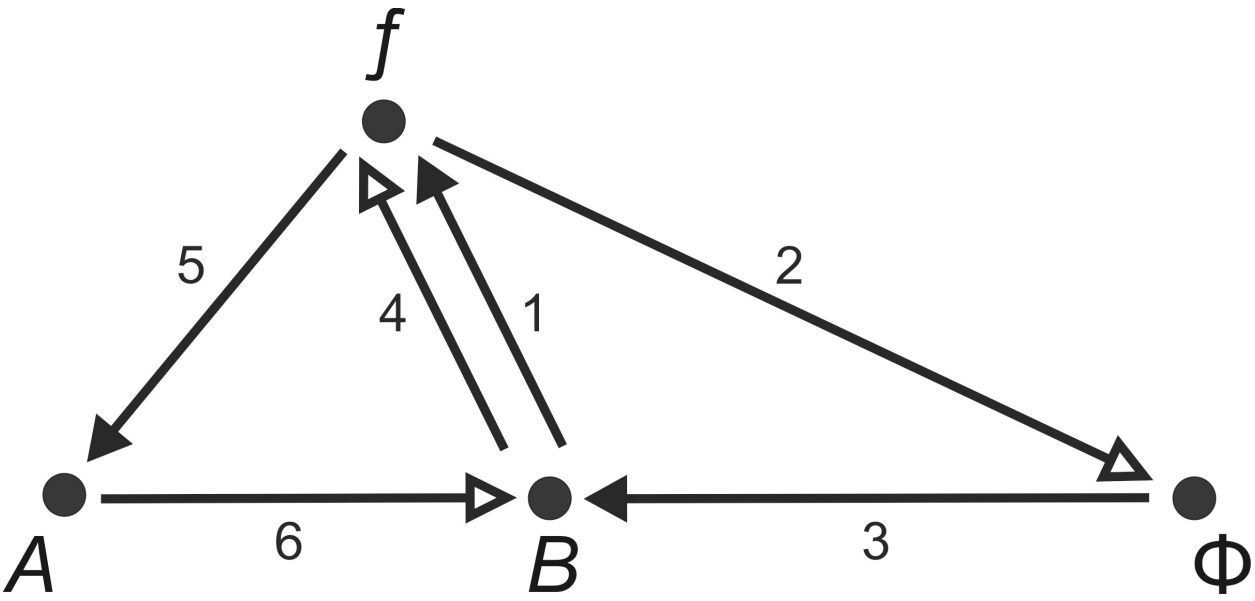

Figure 11: The [M,R] System (Rosen 1991)[89]

[89] Rosen was as "relational biologist" in contrast to analytical biologists who attempted to understood life in purely physicalist terms. Relational biology understands living things as relational systems that are materially realized. Following Louie, "the crux of relational biology is throw away the matter and keep the underlying organization" (Louie 2006). To study these relations, Rosen and his students used category theory, a form of abstract mathematics – colloquially, but not pejoratively, referred to as "abstract nonsense" - that works on the principle of "structure preserving maps". The [M,R] system depicts an abstract "cell" in which functional components appear as relational diagrams (e.g., f: A → B). Hollow arrows represent efficient cause and solid arrows represent material cause. The mapping f represents the efficient causal process by which an enzyme converts resources from the environment into a usable form by the cell (i.e., metabolism). The enzymes must be periodically repaired by a gene, and that requires another functional process that itself depends on the metabolites produced by metabolic process (i.e., ϕ: b → f) to reproduce the gene. In this way, two different efficient causes appear as mutually co-constitutive, and every functional component of the system is produced from within the system itself. All that is required is an initial material input. Note that this description is a gross oversimplification of the M,R system and that better descriptions can be found elsewhere (Louie 2006; Mikulecky 2005; Rosen 1991b). The essential point, for our purpose, is that the life is closed to efficient cause, and that means it is non-simulable.

Impredicativity is the core problem of Gödelian incompleteness. According to Turing himself (see Shagrir, 2002), impredicative relations are incomputable, and thus, life is both complex and non-simulable. Mechanisms, by contrast, are systems whose models can be adequately described and interacted with according to a single, dynamical, computable description. Furthermore, M-R systems are themselves realizations of modelling relations in physiological, psychological, and evolutionary terms, and this observation leads to new and different types of chick-egg paradoxes. For Rosen, like Deacon, the evolutionary process is anticipatory in the sense that it involves the encoding of a predictive model within the somatic embodiment of the organism. Note that this "encoding" involves, but is not limited to, genetics because there exists a near-infinite number of ways that anticipatory information can be encoded into an organism. Rosen pointed to the wintering behaviour of deciduous trees as an example (Rosen, 2012 [1985]). Trees shed their leaves because they cannot function in low temperatures, but the process itself is triggered by reducing sunlight. In some capacity, then, a tree embodies an anticipatory model[90]. For Rosen, as for Deacon, these anticipatory, anticipatory systems represent evidence that the evolutionary process itself is teleodynamic. Life, in other words, evolves as the realization of a particular perspective – one that is both incomplete, situated, reflexive and dynamically shifting – of what it means to exist and persist within a given environment. However, anticipation does not impart consciousness or teleology to the evolutionary process; somatically encoded anticipatory models evolve through natural selection and trial and error as usual. Conscious forms of life then exhibit both somatic and psychological models that are related but also frequently disjointed. You may *know* that you are safe in a dark room within your own home, but you cannot prevent your endocrine system from releasing stress hormones triggered by the dark. Your mind and body have different models for interpreting the world[91].

But analog and cognitive anticipation feed into one another nonetheless. The physical apparatus for cognition, which conditions and constrains, but does not determine how we think, is itself the realization of a somatic-evolutionary modelling process. On the other hand, when we "decode" our

[90] Deacon provides countless additional examples of anticipation/teleodynamism in nature in his text *Incomplete Nature* (2012). Further note that although Deacon does not cite Rosen directly, the similarities between the two were brought to his attention by a reviewer (Brenner 2012), and Deacon has expressed his desire to give attribution to Rosen in the future.

[91] Robert Rosen's daughter, Donna Rosen, is a trans-woman who has described her experience of gender dysphoria, in reference to Rosen's theory, as the experience of disjunction between her somatic and cognitive models.

models, we not only test our theories of how the world works, but we also entrain the world through our interactions with it, consciously or unconsciously, in the image of how we understand it. Evolutionary niche construction (Laland, Matthews, and Feldman 2016; Lewontin 2000) represents the co-evolutionary interplay between organisms and "higher-order"[92], open, anticipatory, self-organizing systems. The relations between life and its environment are both internal (as the environment is encoded into the being of living things) and external (as life decodes a perspective of its model of the environment back onto the environment). In both cases, relations are mutually co-constitutive, but all constitutive relations are predicated on the realizations of partial and situated perspectives. As Mikulecky and Coffman explain, complexity means that "there is always more than one way to skin a cat." Because there can be no one model to rule them all, there is also no ultimate realization of a single, transcendent model of one's environment. For Rosenneans, the reality of partial perspectives engenders pluralization and mutualism (all creatures big and small) as there is no way to be perfectly adapted to a dynamic environment in isolation from other perspectives and their realizations. In Rosen, then, the epistemology and ontology of life form a recursive relationship. We are whole only because we are incomplete.

For Rosen, living things are akin to the Deleuzian concept of "assemblages" insofar as their evolution appears as a process of co-becoming, mutualism, and symbiosis, what Guattari called "creative involution" (see also Pearson, 1999, p. 149; Sandilands & Erickson, 2010, p. 379). Societies, so construed, are realizations of models of the environment encoded vis-à-vis individuals, and they also constitute anticipatory systems in their own right. Politics, so construed, involves both exchanges and contests between proponents of different models that are codified in multiform ways. Power, within this scheme, is both the "power to name the world" (Bird 2016) and or, in Whiteheadian terms, the "relational power" to be affected by it (Mesle 2008). In accordance with the radical democrats, political contestation – the contest of models - is never settled *because* the relational, anticipatory process is never complete. We might also recognize that "naming the world" should not be interpreted in purely linguistic and discursive terms. Just as Rosen recognized that there is an infinite number of ways that somatic models might be encoded beyond the intertextual "physical memory" of genetic structures, we should also recognize that our "social models" might be encoded and decoded extralinguistically. Following Conolly, we "name the world" in an infinite number of ways: legal statutes; cultural norms; taboos; religious rituals; art and music; idioms and witticisms; pronouns; organizing metaphors;

[92] Note on Allen and Hierarchy

scientific theories; acts of solidarity or micro-aggression; zooming bylaws, or; through our micro-affective modes of communication, including bodily disciplines that act on the "visceral register of culture": "gesture, posture, facial expression, distinctive rhythms of expression, hand movements, tones of phrasing, jaw settings, habits of eye contact, and styles of walking" (Connolly, 2017, p. 14).

This interpretation of complexity – "thick" complexity – turns reductionism on its head by asserting that complexity is the word we use to describe the experience of encountering not only the epistemological limits of inferential entailment (i.e., logic, which is not the same thing as reason), but also how those limits both allow for the possibility of, and are made manifest within, a creative universe of becoming through codetermination and facilitating relationships, including, but not limited to, the facilitative constraints imposed by one's environment. Complexity is, therefore, a general quality of reality as opposed to something we encounter in abnormal circumstances. Following Allen (who is a staunch Rosennean), "thick" complexity in this regard is not measurable - a system is either complex or it is not. But when Allen says this sort of thing, it is with the recognition that it is the *observer* who determines the boundaries around that which constitutes a "system" (Allen and Ahl 1996). When Rosenneans identify a "system" as "complex", what they are really saying is that the interplay between an identified assemblage of percepts generates phenomena that confront us with the implications of incompleteness in both ontological and epistemological terms.

These insights have been subtly distorted in contemporary systems discourse, and although I will not speculate on why that might be, it might be instructive to ask how it occurred. Like the subtle analogy between thermodynamics and computational mathematics that folds together complex adaptive systems and non-equilibrium thermodynamics, the conflation of Rosennean complexity and Neumannian-algorithmic complexity relies on an implicit analogy between *non-linearity* and *impredicativity* that is present in the various non-equivalent descriptions of causal closure that one finds in systems theory - e.g., cellular automata, or system dynamics. As Zellmer at al. explain, the latter two deal with causal closure as a matter of non-linearity, whereas Rosen described causal closure in terms of inpredicativity. George Richardson, who is the preeminent scholar on the concept of feedback in social theory, describes the difference as follows:

> [Gödelian] self-referential systems are perilously close to our concept of feedback, particularly if one views feedback, as Wiener phrased it, as "the transmission and return of information." Yet, it is important to realize that they are not the same as the positive and negative feedback loops that are the central focus of this study. Circular causal, feedback

> processes as we have characterized them do not have the potential to be self-contradictory. Loops whose elements are statements or messages can be paradoxical in that fashion, but the primary focus of this investigation is on loops containing variables that can be interpreted as quantities that increase or decrease over time. If an increase in a quantity in such a loop feeds back eventually to produce a decrease in that quantity, we have a negative loop, but not a self-contradictory loop (G. P. Richardson, 1991, p. 58).

Following Poli, both linear and non-linear simulation are types of predicative modelling that do not involve logical self-reference. Non-linearity, unlike impredicativity, is both computable and simulable. And this is why, for Rosen, dynamical systems theory (e.g., Bertalanffy) struggled methodologically (not philosophically) to break free from the Newtonian paradigm (i.e., why systems theory was forced to attempt to subvert the machine metaphor by using the "tools" of the mechanist). Indeed, as my discussion of Rosen and Berlinksi in Chapter 2 of this text illustrates, there is no essential difference between the difference equations from the dynamical systems of Newton and the system dynamics of Forrester or the general systems theory of von Bertalanffy. Forrester's models simply required powerful computers due to the sheer volume of equations that needed to be performed. Rosen, like Bertalanffy and Forrester, also attempted, at first, to use dynamical systems theory to simulate the M-R system, but the attempt failed due to what he called "the inequivalence of causal categories" implied by incompleteness. Ultimately, Rosen's "modelling" work was done exclusively through category theory (see Louie, 2010).

Rosen describes this problem through a critique of von Neumann using Aristotle's four causal categories[93] as heuristics (e.g., material cause, efficient cause, formal cause, and final cause)[94].

> Long ago (cf. Burks, 1966) John von Neumann gave a discussion of a putative "self-reproducing automaton." This discussion was based on the idea of a "universal constructor," which was in turn derived from Turing's earlier (1936) idea of a universal digital computer, or universal Turing machine. Basically, von Neumann's argument was that following a blueprint to construct something was just as much of an algorithmic process as

[93] Very briefly: the *material cause* for a house would be the building materials used to make it (wood, stone, clay, etc.); the *efficient cause* for the house would be the process of building it (carpentry, masonry, etc.); the *formal cause* would be the blueprints; the "recipe" for how to build a house, and; the *final cause* would be what purpose the house satisfies: the need or desire for housing.

[94] Note this should not suggest that Rosen in any way adopted Aristotle's metaphysics. Many philosophers use the four causes as short-hand, heuristic devices).

> following a program to compute something, and therefore that anything true of computation was necessarily equally true of construction. But of course a constructor must manipulate material causation, while a computer manipulates efficient causation; it does not follow, and is in fact false, that a universal simulator implies anything about a universal constructor. Indeed, for the same reason, one must be very careful in extrapolating from the properties of formal systems such as neural networks or automata back to the material properties of such processes as biological development or cellular control; for these too are exercises in the realization of efficient causation by material causation in some prototype… Going the other way, we cannot predict, for example, that a given material structure will play any particular kind of functional role (e.g., that a particular protein structure is an enzyme, let alone what its substrates are). And even in pure mathematics itself, results like Gödel's incompleteness theorems are manifestations of this same inequivalence, now expressed in completely formal terms (Rosen 1985a).

Kineman has termed "the relational holon"; the idea that life and its manifestations are the result of the interplay between non-equivalent categories of causation. Life is closed to efficient cause, but it is open to material cause. Its functional organization mode both realizes and is the realization of formal causes (i.e., models) that are reflexively adapted to suit a plurality of final causes (including, but not limited to, dissipation and metabolism). Many of the problems we have encountered throughout this text arise out of attempts to reduce one form of causality to another. For Georgescu-Roegen as well as Daly and Cobb, the conceit of neoclassical economics laid in the reduction of the economic process to formal and efficient causation[95]; material cause – the biophysical dimension - is ignored. Cellular automata research (originally intended for economics by von Neumann) reproduces this problem by assuming that construction in material terms engenders causal correspondence with algorithmic procedures. Odum, thereafter, attempted to counter the anti-materialism of economics by reducing ecological and economic processes to material and efficient causes (i.e., Maximum empower). What neoclassical economics, biophysical economics, and cellular automata have in common is that they all collapse non-equivalent causal categories (albeit with an emphasis on different specific categories). In all of the above cases, final causes are neglected. What I am interpolating from all of these discussions, through the lens of Rosen, Whitehead, and Connolly, is that a satisfactory political economy must be grounded in a social

[95] See Georgescu-Roegen, 1972, ch. 7 and Daly and Cobb 1994.

ontology that accounts for the interplay between non-equivalent causal categories and that there are always consequences for failing to do so.

Rosen's theory, then, creates new distinctions while eliminating others. The distinction between epistemological complexity and ontological complexity becomes a matter of recursion. The distinction between organism and mechanism becomes contingent on the distinction between logical impredicativity and predicativity (including both linearity and non-linearity). Impredicativity provides the distinction between "thick" complexity and "thin" complexity, or, put otherwise, computability and non-computability; simulability and nonsimulability. Accordingly, Rosen's anticipatory systems explicitly preclude the possibility of "true" artificial intelligence and digital life because computers are neither capable of "truly" random behaviour nor creativity. A computer must be instructed how to encode percepts into a formal system of inference, which means that both encoding and decoding are formally entailed when it comes to artificial intelligence[96]. Rosen reflected that the Turing test is a poor metric by which we determine life from non-life because he accounted for the possibility that computer technology could produce convincing simulations of life but not life itself. What this means is that cellular automata might produce convincing simulations of ecosystems, and in producing those simulations, we may learn a great deal about the constraints and dynamics that potentially delimit the possibilities available to anticipatory systems, but we cannot predict what the system will do. Crucially, this uncertainty stems from ontological indeterminacy in addition to epistemological constraints.

In Rosen's theory, then, we have a *strong* counter-point to both technocratic optimism and technological fetishism, but this should not be interpreted as a categorical rebuke of teleonomic systems approaches such as system dynamics, non-linear dynamics, or cellular automata. Rather, Rosen's theory merely places boundaries on what those approaches are capable of predicting. In doing so, one might say that Rosen is actually protecting systems theory by attempting to preclude its misuse through reductionism and determinism. In the parlence of post-normal science, Rosen is essentially identifying a region within either the upper limits of expert science or the lower bound of post-normal science that pertains to situations involving teleonomic systems that are subject to inherent uncertainty. Researchers may debate this claim, but I maintain that the distinction between teleonomy and teleodynamism

[96] Rosen conceded that it is perfectly possible to produce a convincing computer simulation of life, but he maintained that the simulation did not constitute life itself because he viewed the "unentailed" creativity involved in encoding and decoding as an inextricable quality of life. With that said, Rosen could not have predicted the current renaissance in learning algorithms, and I cannot speculate, based on his assertions, what the potential implications of the ongoing renaissance in learning algorithms will be.

effectively removes "thin" complexity from the domain of post-normal science[97]. This may seem like a radical position, but I argue that it is implicit in the logic of post-normal science itself. Consider this passage by Funtowicz and Ravetz:

> The social and intellectual contexts of scientific work have been transformed by the new problems of risks, the environment and public suspicion of the works of science. There have been many attempts to achieve more sophisticated versions of reductionist science, employing a variety of mathematical techniques, ranging from games theory to Bayesian statistics and catastrophe theory, and including systems analysis at one stage. The recent growth in the appreciation of complex systems indicates a change in attitude and direction. For mathematics is becoming a means of insight and understanding rather than a portrayal of a timeless essence. This new attitude will enable a resolution of the fragmentation of knowledge that has resulted from the collapse of the hegemonism of the old reductionist conception of science. Appreciation of diversity, which is not at all the same as relativism, can lead to a new practice of science in emergent complex systems. This is what we call post-normal science. *Emergent complexity provides a theoretical justification for post-normal science, in which the peer group for quality assurance is expanded beyond the certified experts to include all those with a stake in the issue. This concept helps us to appreciate that there is no single perception providing a comprehensive or adequate vision of the whole issue, nor any particular criteria of quality that can hegemonically exclude all others. Casti has expressed the point of a plurality of legitimate alternative perspectives by equating degree of complexity with the number of non-equivalent descriptions of a system* (Funtowicz & Ravetz, 1994, p. 578).

The fact that Funtowicz and Ravetz attribute this idea of a "plurality of legitimate alternative perspectives" to Casti is significant because Casti subtly appropriated *Rosen's concept of complexity.* He did not, however, always properly attribute these ideas to Rosen. In one article, Casti (1992), for example, describes Rosen's theory of the modelling relation in minute detail, all while using Rosen's distinct phrasing and terminology and with the use of Rosen's distinctive diagrams, but Casti never once

[97] Another perhaps more conciliatory possibility might be to suggest that this distinction provides the basis for what some are calling 'post' post-normal science (O'Brien 2013; Ravetz 2006): "towards an integrated understanding of change based on critical research on space, place, politics, power, culture, identities, emotions, connections, and so on, including the geography of care" (O'Brien, 2013, p. 593).

mentions Rosen by name or with proper citation[98]. Importantly, this article was published in the *Bulletin of the Santa Fe Institute,* which constitutes a central and significant forum for complex adaptive systems research, and this is significant because, while it describes many components of Rosen's theory of the modelling relation faithfully (albeit without attribution), it conspicuously avoids the point that Rosen's theory was conceptually inseparable from his critique of von Neumann's cellular automata that complex adaptive systems employ. For Casti, "multiple perspectives" can include various models with different variables but within the same analytical framework. Furthermore, Casti insists that complexity can be made *objective* by *quantifying* the number of ways that we can describe a given system. If we accept Rosen's theory, however, such an operation is, in principle, undecidable, and thus, Rosen's concept of complexity is not quantifiable (see Allen et al., 2017). In this way, Rosen's theory was subtly altered and made more amenable to complex adaptive systems research. The "fuzzy" line between expert science and post-normal science is a consequence of this partial reading of Rosen's work.

These simple genealogical observations may or may not explain entirely *how* Rosen's thick complexity came to be ultimately conflated with thin complexity, but it does mark a significant instance in which this conflation occurred. Rosen's ideas, filtered through complex adaptive systems discourse, were rendered inert as they were stripped of all ontopolitical content and implications. This is important because, although Rosen is generally today only discussed by biologists, mathematicians, and systems researchers, it is noteworthy that he developed his theory of anticipatory systems during his residence as a visiting fellow at The Center for the Study of Democratic Institutions, founded and directed by Robert M. Hutchins[99] in the company of primarily political scientists, linguists, economist, and philosophers. Much like Bertalanffy, he noted parallels between his relational theory of biology and the

[98] In fairness, this may have been due to editorial oversight since the *Bulletin of the Santa Fe Institute* was not an academic journal and did not publish references after articles. This does not, however, explain why Casti did not mention Rosen by name in the article itself, nor does it change the fact that he draws implications from Rosen's theory that were contrary to those drawn by Rosen himself. Intriguingly, in the very next issue of the *Bulletin*, Casti (1992a) penned a somewhat lukewarm review of Rosen's 1991 book, *Life itself* (published over a year prior), but at no point in the article does he mention Rosen's definition of complexity, nor does he address the fact that he did not attribute the idea to Rosen in his previous editorial.

[99] Hutchins himself was an American intellectual giant who served as the Dean of Yale Law at age 21 and as the President of the University of Chicago at age 30. Among other things, he was famous for his intellectual rivalry with John Dewey and their extended public debate on the subject of moral teleology. He also succeeded Dewey as the President of the University of Chicago where he repeatedly, and unsuccessfully, attempted to dismantle many of the reforms that Dewey had previously instated. Hutchins was famously suspicious of both natural and social scientists, but he invited Rosen due to what appeared to be strong parallels between Rosen's relational biology and the structuralism of Levi-Strauss[99].

structuralism of Levi-Strauss. That is, Rosen's approach to relational biology used category theory to map sets of relational processes between functional components within living systems (once again, relations of efficient causation have as much if not greater ontic status than the physical material that comprises living systems). The social scientists he engaged had hoped that his uniquely relational perspective might provide biological insight into society beyond crude social Darwinism (which, as we have seen, was grounded in the very sort of analytical-biological theory that Rosen critiqued). Contrarily, it was Rosen's hope that through his engagement with the Center and by investigating relational patterns common to both societies and organisms, it would be then possible to glean insights into biology vis-à-vis sociology. Rosen's theory, in other words, *was always intended to be used by social theorists* as an alternative to the computational modelling approaches of Forrester and von Neumann.

> What should we do now? To one degree or another, that was also what the economists, the political scientists, the urban planners, and all the others wanted to know. However different the contexts in which these questions were posed, they were all alike in their fundamental concern with the making of policy, and the associated notions of forecasting the future and planning for it. What was sought, in each of these diverse areas, was in effect a technology of decision making. But underlying any technology there must be an underlying substratum of basic principles: a science, a theory. What was the theory underlying a technology of policy generation? … In some very real sense, then, the Center was entirely concerned with the construction and deployment of predictive models, and with the use of these predictive models to regulate and control the behaviors of the systems being modelled… in one form or another, much attention at the Center was devoted to instances of conflict, whether it be between individuals or institutions. That was what law, for example, was all about. In each specific case, it appeared that the roots of conflict lay not so much in any particular objective situation, but rather in the fact that differing models of that situation had been adopted by the different parties to the conflict. Consequently, different predictions about that situation were made by these parties, and incompatible courses of action adopted thereby. Therefore, a general theory of policy making (or, as I would argue, a general theory of modelling) would have as a corollary a theory of conflict and, I hoped of conflict resolution (Rosen, 1991a, p. 543).

What Rosen achieved, however, through his insights on complexity, incompleteness, and self-reference, was arguably the opposite of a theory of conflict resolution: it was a theory of the inevitability of conflict

due to the incommensurability of different formal systems of inference used to describe living systems (including societies). The philosopher and complexity theorist, Paul Cilliers (Cilliers 1998, 2005, 2010b), has made the remarkable insight that the "multiple perspectives" interpretation of complexity (which he appropriately attributes to Rosen) is analogous to Jacques Derrida's critique of logocentrism (i.e., "the illusion that the meaning of a word has its origin in the structure of reality and at the same time makes that truth part of that structure seem directly present to the mind" (Ellis 1989, p. 37)). In essence, Derrida was reflecting on the consequences of the fact that meanings are undecidable because semiotic systems are always incomplete[100]. Derrida, like Foucault, was a "post" structuralist in the sense that both turned the tools of structuralism back on itself so as to demonstrate that structural analysis could never be objective, apolitical, and value-free. Similarly, Rosen turned the relational approach of general systems theory back on itself by observing that models are relations between natural and formal systems. In this sense, the undecidability of logocentrism and the incompleteness of complexity are two sides of the same Gödelean coin, and through Cilliers, we observe an affinity between these two deeply misunderstood and much-caricatured epistemological traditions. "The aim … is to argue for the importance of modest positions when trying to deal with complex problems. Deconstruction serves as an example, and I will argue that the view from complexity serves as another, or rather, as a complementary one. The dismissal of everything postmodern will therefore include the dismissal of a number of important insights from our understanding of complexity… The failure to acknowledge the complexity of a certain situation is not merely a technical error but also an ethical one. A modest position should not be a weak position but a responsible one."

Cilliers, however, made the connection to Rosen gradually and over the course of many decades. His 1998 text, *Complexity and Postmodernism*, and his 2005 article, *Complexity, Deconstruction and Relativism*, both define complexity in terms of multiple perspectives, but, not unlike Berkes et al., he also tentatively presents a pseudo-conventionalized interpretation that defines complexity in terms of ten key characteristics[101]. Upon reflection, Cilliers Cilliers, 2010 notes, as I have here, that these two

[100] Derrida illustrated this point with Gödel on multiple occasions (e.g., Derrida, 1981, p. 85).

[101] See Cilliers, 2005, p. 257. What Cilliers provides is essentially a more detailed account of conventionalized complexity than that provided by Berkes et al. The final point on the list is uncited, but it is unmistakably Rosennean: "More than one description of a complex system is possible. Different descriptions will decompose the system in different ways. Different descriptions may also have different degrees of complexity." The latter half of this sentence is, however, is revealing because Rosen did *not* suggest that relational complexity could be

interpretations are inconsistent, and although he does not expound on this line of thinking, he distinctly points to Rosen as a key perspective in differentiating "general" complexity from "restricted complexity" (a distinction he attributes to Morin).

> In the first place one has to acknowledge that the "discipline" of Complexity is a house divided. There are serious differences between different approaches to complexity. After about two or three decades of work explicitly dedicated to the understanding of complex systems, it has become crucial to reflect critically on the value of these different approaches. One way of distinguishing between these approaches is provided by Edgar Morin (2007) who distinguishes between "general" and "restricted" complexity. Restricted complexity refers mainly to the mathematical and computational approaches to complexity, often strongly informed by chaos theory. This approach, Morin argues, acknowledges the non-linear, relational nature of complex systems, but seeks to tame it in ways which reintroduces positivism and reductionism. General complexity on the other hand, argues for the limits of all approaches to complex systems and urges that we acknowledge these limits and recognise that we need a new language in which to do this, a language which moves beyond Enlightenment ideals of neutrality and objectivity. Whether we can find such a language remains, also for Morin, a contested idea (Cilliers, 2010, p. 41).

Once again, this distinction between general and restricted complexity is equivalent to Strand's distinction between "thick" and "thin" complexity, Funtowicz and Ravetz's distinction between complexity and emergent complexity, and; Rosen's distinction between complexity and "complicatedness." But only Rosen established that impredicativity and anticipation (i.e., teleodynamism) constituted the hard line between them, providing an epistemologically useful concept of "the limits to all approaches to complex systems." For Rosen, the line between complicatedness and complexity is the line between teleodynamism and teleonomy, as well as the line between mechanisms

quantified. Thus, we can surmise that at this point in his thinking Cilliers was operating with Casti's reinterpretation of Rosen's definition of complexity.

and *life itself*.

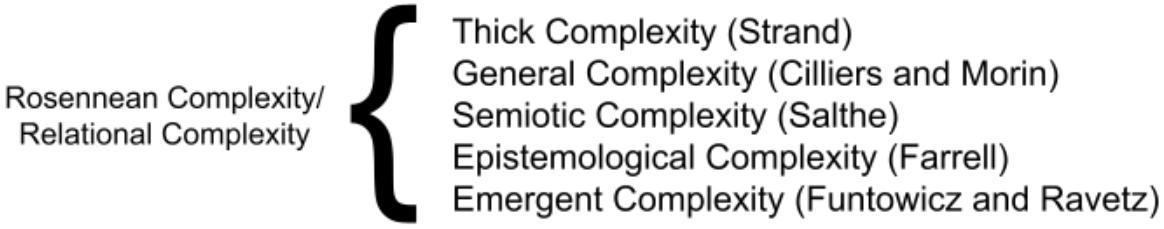

Figure 12: I am suggesting that all of the different concepts of "thick" complexity can and should be understood as different expressions of Rosen's "relational" complexity. Cilliers and Salthe explicitly point to Rosen, whereas Funtowicz and Ravetz point to Casti, whose concept of complexity relies on a simplified (and unfortunately distorted) interpretation of Rosen. Farrell's (Farrell 2009)*"epistemological complexity" is comparable to Rosen's concept of the modelling relation, but one should note that Relational complexity also involves an ontological component (i.e., interactions between non-equivalent causal categories; what Kineman calls the "relational holon"). As far as terminology goes, I still favour Strands term "thick" complexity due to its simplicity and generality (but relational complexity is another strong contender). Although I think Rosen's insights should be acknowledged, I suggest that a more neutral term than "Rosennean" complexity should be adopted to allow the concept to grow and accommodate future insights.*

By bringing these conceptual schemes into alignment (see Figure 13), it becomes possible to use Rosen, vis-à-vis Cilliers and Connolly, as a cypher for translating between post-structuralism and post-normal science. It also becomes possible to look backwards and assess how and why many exchanges between social theory and systems theory went wrong.

5.3: Complexity and Anti-pluralism

To re-cap, Walker and Cooper claim that systems theory has become an instrument of hegemony, and although I disagree on them on many points, I think this claim is worth taking seriously. However, rather than asserting that there is a natural affinity between systems theory and neoliberalism, I think it is the critical task of the genealogist to interrogate the discursive practices used to bring those ideas into congruence. Following Connolly, having separated the elements of the rhetorical *chimera* into its constituent elements, the normative task of the genealogist is to consider how those pieces might be

reformed, repurposed, and reconfigured for more generative purposes. Simultaneously, we might also proceed with more attention to the ways in which key distinctions might preclude the possible misuse of systems concepts by anti-pluralists.

The idea of non-equivalent perspectives is not, in and of itself, an insight that lends itself to pluralistic political implications. That is, when stripped of its ontological content – i.e., that life involves the interplay between non-equivalent types of causation and that it both realizes and is the realization of incompleteness– then it is easy to see how ideas about situated perspectives and complex wholes can potentially lead us to distinctly anti-humanist and anti-pluralist ontopolitical orientations. To illustrate this point, I point to three significant conservative theorists – Luhmann, Hayek, and Banfield - and attempt to demonstrate how key features of their theoretical frameworks rely on the reduction of teleodynamism to teleonomy.

5.3.1: Luhmann's Social Systems Theory

Luhmann's social systems theory (see Luhmann, 1995 [1984]) extends the structural-functionalist tradition of Parsons. Parsons, in turn, extended Pareto, and Pareto extended Spencer. All were interested in the question of social reproduction. For Pareto, social reproduction was the biological reproduction of the people living in society; for Parsons, societal reproduction was the reproduction of "roles", and; for Luhmann, social reproduction was the reproduction of meanings. Following Poli, the functionalist tradition thus "de-materializes" over time, and we are ultimately faced, once again, with the familiar problem of non-equivalent causal categories and their consequences in social theory.

For Luhmann, the basic units for social reproduction are communications that require both "utterance, information and understanding" (i.e., a speaker, the spoken word, and a listener). Social systems emerge when communications are used to coordinate actions between individuals, and the social system persists for as long as those communicative processes are reproduced. Social systems are, therefore, following Maturana and Varela, autopoietic (i.e., self-producing) systems that are operatively closed and distinct from their environments in the sense that it is not possible for information to transfer directly between the system and its environment (as with, for example, dissipative systems). According to Luhmann, autopoietic-social-systems-of-communications constitute differentiated functional subsystems (e.g., politics or the legal system) of a society that are structurally coupled to reproduce the societal whole, which itself constitutes an autopoietic system (Luhmann 1986). However, because the level of the whole society constitutes the environment for the social subsystems that we participate in,

we are unable to make direct informational exchanges with the system itself, and so, we are unable to intentionally transform our societies. For this reason, Luhmann's theory was considered anti-agential, and he himself was considered by many to be an anti-humanist (see Moeller, 2012). I cannot engage with every facet of Luhmann's theory, but for our purposes, I do not need to. The key point is that although Luhmann's social systems theory contains many elements found in Rosen - incompleteness, self-reference, and causal closure – it brings us to distinctly different ontopolitical implications[102] because key distinctions are left unmade.

Cilliers notes that in Luhmann's theory of social evolution we see both elements of "thin" complexity and "weak" post-structuralism. Turning again to Derrida, Cilliers reiterates that the impossibility of standing "outside" of a system that one participates within does not preclude the possibility of transforming that system:

> Traditional interpretations of the temporal nature of a system, including Luhmann's position, privilege the present. The immense gain of the notion of différence is that it reminds us that not only the past has to be considered when we try to establish the meaning of (say) an event, but that since we cannot fully predict the effects of this event, the future has to be considered as well, despite the fact that we have no idea what this future might be. Now, instead of throwing up his hands, and declaring that in such a case it is impossible to talk about meaning, and that therefore anything goes, Derrida insists that we should take responsibility for this unknowable future. In the case of ethical decisions, this leads to an aporia (133–135): we have to take responsibility for the future effects of our decisions, but we cannot know those effects, nor can we wait to see what they are. We have to make the decision now (Cilliers, 1998, p. 139).

Our visions of the future will never be fully realized, but they do transform society insofar as they serve as "attractors" that condition the perceived degrees of freedom available to the system. Following Poil (2010), the issue with Luhmann's theory is that it lacks a concept of anticipation, and this, in his view, is a consequence of Luhmann's interpretation of autopoiesis.

[102] From one of Connolly's earliest texts: "These theories, it is feared, could help to legitimize a movement to disconnect state activity from effective accountability. Systems theorists — Luhmann is the leading example — provide the most blatant instance, for they would increase state effectiveness by freeing it from the obligation to defend the rationale for its policies to a wider audience" (Connolly 1987).

Numerous researchers have noted similarities between Rosen's theory of the [M,R] system and Maturana and Varela's theory of autopoiesis. In general, both theories concerned systems that were operationally closed insofar as their functional components are mutually produced and reproduced from within the structure of the system itself. But it is the differences that "make a difference" in terms the effects that both theories have when they are deployed within social theories. To understand this, it is first important to note that both theories developed independently. Although Rosen's theory predated Maturana and Varela by nearly two decades, there is no historical evidence that either side had any awareness of the other. Rosen was a relational biologist in the tradition of Nicholas Rashevsky (a tradition that is generally more conversant with general system theory), whereas Maturana and Varela's theory derives from the tradition of second-order cybernetics. As such, the theory of autopoiesis is nowhere concerned with distinguishing between machines and organisms because, following Haynes, the purpose of cybernetics was to attempt to recover the human subject by demonstrating the *similarities* between machines and life. Accordingly, autopoietic systems are essentially teleonomic insofar as Maturana and Varela understood *purpose* as pertaining to function and, thus, was only coherent within the context of the functional organization of a closed whole and not beyond that Maturana and Varela's intention for this approach was to preclude teleology (whereby purpose is exogenous to the whole entity), but, as a secondary consequence, autopoiesis also precludes teleodynamism (see Thompson, 2007, p. 144-147).

Furthermore, Maturana and Varela considered autopoietic systems to be strictly biological. Unlike Luhmann, they did not consider societies to be autopoietic entities, and unlike Rosen, they did not intend for the concept of autopoiesis to be used by social theorists per se. For Maturana, "natural social systems" can act as *mediums* for autopoietic entities[103], but they are not themselves autopoietic, and the fact that autopoietic systems ascribe uncrossable boundaries between themselves and their environments, it does not necessarily follow that "natural societies" comprised of autopoietic entities are similarly restricted. For all of these reasons, contemporary autopoiesis researchers, who, unlike Maturana and Varela, have studied Rosen's theory in detail, have concluded that the M,R system is simultaneously more specific and more general than the theory of autopoiesis, and this suggests that autopoietic systems constitute a *special class* of M,R system (see Letelier et al., 2003). As Thompson notes, this claim constitutes a serious challenge to complex adaptive systems researchers who have long

[103] For a more fulsome discussion on Maturana's (1981) theory of "natural social systems" as well as key critiques of autopoiesis in Luhmann's social systems theory, see Mingers (1994, 2002).

claimed that cellular automata can be used to represent autopoietic systems. By aligning autopoiesis with the M,R system, autopoiesis researchers are de facto adopting Rosen's argument against Strong Artificial Life: "the phenomenology that arises from the circularity of metabolism cannot be simulated with current computer architectures based on the Von- Neumann implementation of Turing machines" (Letelier et al., 2003, p. 270).

The differences and similarities between autpoiesis and the M,R system are equally substantial. Since it has been established that we are discussing more or less general conceptions of essentially the same concept (i.e., causal closure), it behooves us to explore how various theories that employ autopoiesis *change* when we remove autopoiesis and substitute it for Rosen's relational complex (i.e., the M,R system and the modelling relation). In the case of Luhmann's social systems theory, the entire structure of the argument breaks down for several reasons. First, the M,R system pertains specifically to systems that are thermodynamically open and reproduce themselves through closed metabolic patterns. In general, this description *does not* include what functionalists describe as "functional components" of societies, such as markets or legal systems. Luhmann describes these "sub-systems" as individual autopoietic entities and, under Rosen's theory, that interpretation is not tenable. To explain this distinction with an organic analogy, we might note that the body of an organism is made up of individual cells, much like a society is made up of individuals. Cells and people *do* constitute M,R systems (bodies and societies, respectively), but functional subsystems within a whole entity (e.g., an organ in the soma of an organism or an institution in a society) do not constitute M,R systems in and of themselves. Once again, following Deacon, teleodynamic systems operationalize teleonomic systems to serve various purposes. This suggests that while the social systems are teleodynamic, their subsystems are functionally teleonomic, and so we should not use the same analytical framework to understand both in equivalent terms. In Rosen's terms, it may be possible to understand institutions in cybernetic-teleonomic terms because institutions are imperfect realizations of incomplete inferential models and are, therefore, *constructed* to behave like servomechanisms. Conversely, it should also be understood that Rosen's theory does not ascribe greater complexity to encompassing or "contextualizing" systems (i.e., systems that other systems exist within). For example, Rosen opposed Lovelock's Gaia Hypothesis (Lovelock 1972), and he did not consider the Earth system itself to be either living or complex[104].

[104] Mikulecky (2005), although he is among Rosen's most ardent proponents, disputes this point and argues that the Earth is an M,R system.

Luhmann's theory is anti-humanist insofar as it generalizes teleonomy to the whole system and, therefore, eliminates agency at the highest level of social organization. M,R societal systems, by contrast, are agential insofar as their behaviour reflects the perspectives of the community of agents – or communities of communities of agents - who are, through political *action*[105], creatively encoding and decoding the inferential models that drive anticipatory behaviours. Rosen's theory, in other words, reinstates both agency and praxeology in social affairs, dimensions that are otherwise absent under the teleonomic regime of autopoiesis. Rosen's theory, then, provides the very sort of alternative, agential and co-creative conceptualization of holism and causal closure that many social theorists have called for. Guattari, for example:

> autopoiesis, which uniquely defines autonomous entitles - unitary, individuated and closed to input/output relationships - lacks characteristics essential to living organisms, like the fact that they are born, die and survive through genetic phylums. Autopoiesis deserves to be rethought in terms of evolutionary, collective entities, which maintain diverse types of relations of alterity, rather than being implacably closed in on themselves (Guattari, 1995 [1992], p. 40).

Indeed, if we replace Maturana with Rosen in Luhmann's theory, then our image of a society is distinctly more akin to Deleuze and Guattari's Rhizome, but with the added note that although an MR system can be realized in infinitely "diverse types and relations of alterity", they *must* do so in such a way that ultimately realizes a meta-relation of metabolism and repair (even rhizomes need food and care). In this important respect, Rosen's thinking deviates from second-order cyberneticians such as Bateson and Rappaport. M,R systems are relational systems that are *materially realized*, and, as such, they are subject to both the indeterminacies and constraints that animate non-equilibrium, thermodynamic systems. An M,R system is not a "mind" in the Batesonian sense; it is both the realization of mind, and it provides the facilitative physical constraints necessary for mind to emerge. The semiotic complex of anticipation and the somatic complex of the M,R system are mutually dependent and mutually constraining. Each conditions the self-organizing capacity of the other, even though each is subject to a fundamentally different self-organizing process due to the non-equivalence of causal categories. This

[105] In her distinction between labour, work, and action, Hannah Arendt associates the concept of labour with the Greek concept of "*poiesis"* (i.e., sterile fabrication) in contrast to the concept of "*praxis"* (i.e., intentional creation) associated with political action.

approach, in effect, avoids the pitfalls associated with using one concept of self-organization to describe both psychological and physiological processes in equivalent terms. For example, the fact that Spencer's universal principle of evolution used a physical-teleonomic analogy to describe social, political, and psychological (i.e., all semiological) processes paradoxically made it possible for neoclassical economists to later ignore the biophysical dimension of economic production altogether. Once again, this discussion underscores the need for an ecological political economy that affirms holism whilst remaining cognizant of the interplay between non-equivalent and irreducible causal categories.

5.3.2: Hayek, Spontaneous Order, and Neoliberal Evolutionism

Hayek, influenced and encouraged by Hardin (Oliva 2016), adopted Wiener's concept of the purposive machine (i.e., servomechanisms) to describe the spontaneous order of free markets. Classical cybernetics, however, although it explicitly eschews final cause in the servomechanism itself, it affirms agency in the human subjects that develop servomechanisms for their own purposes. This distinction, however, is subtly undermined in Hayek's theory. For Hayek, predictive, adaptive, self-organizing behaviour in economic processes (e.g., the price system) is cybernetic, deterministic,and teleonomic[106], and, once again following Hardin, he asserts that systems of spontaneous order passively develop predictive models through chance, competition, and selection[107] of alternatives based on the path of least resistance: 'what may be called the natural *selection* of rules will operate on the basis of the greater or lesser efficiency of the resulting *order of the group*' (Hayek, 1967, 279).

Following Bertalanffy, however, Hayek notes that although systems of cybernetic feedback regulation can account for spontaneous order, they cannot account for the higher-order rules constraining and contextualizing that order, i.e., cultural and legal rules that are subject to change. In Bertalanffy, this is the difference between primary and secondary regulation, which constituted the distinction between cybernetic and general systems. Hayek differentiates between market self-regulation (i.e., secondary regulation) as a cybernetic system, whereas the societies that rely on them are general systems that are

[106] For Rosen, the fact that there is no "rote" means of determining how to either encode or decode one's observations into formal systems of inference constituted a significant problem.

[107] From Hayek 2014 [1952], p. 242-243: "In particular, the representation of the effort involved in the different courses of action will normally be charged with the representation of pain, or operate as something to be avoided, unless compensated for by the greater attraction of the result. The interaction of all these forces in the end will bring it about that from the possible courses the 'path of least resistance' will be chosen; while all the unduly painful courses will be avoided which might produce the same result, as well as courses leading to alternative results but requiring greater effort."

thermodynamically open and equifinal. Both systems are evolutionary in the sense that they are subject to selective pressure, but only societies as higher-order, open, general systems are capable of adaptation through *structural* change – i.e., what Hayek called "cultural evolution." Critically, however, although Hayek differentiates between cybernetic and open systems, he applies the same functionalist evolutionary logic to both. Cultural evolution, in other words, is a recursive process that acts on groups of individuals to select moral and legal rules that result in the most efficient orders. The efficiency of a society's self-regulating mechanisms, in turn, constitutes the mechanism by which groups gain competitive evolutionary advantages. In this way, the teleonomic, servomechanical logic of the lower-order processes becomes generalized to the whole of the social system, and the result is nothing short of social Darwinism[108]. This may suggest one reason why Wiener expressly forbids the application of classical cybernetics to the study of economics[109] (i.e., the physics envy of economists and their desire to reduce economics to a "mechanics of self-interest and utility"). It might also suggest why Bertalanffy was distrustful of attempts to merge cybernetics and general system theory. Neither Bertlaanffy nor Wiener sought to reduce human agency to teleonomy.

This discussion could be taken to contradict my earlier discussion on Walker and Cooper's critique of resilience from Chapter Three (i.e., claiming that it aligns with Hayek), but I maintain once again that while Hayek's approach is similarly teleonomic, it more closely reflects neoliberal *misinterpretations of* Holling's theory than Holling's theory itself. Although he struggles to articulate this point, Holling consistently acknowledges that social systems are *reflexive,* and their behaviour is not merely an epiphenomenon of selective processes. I recognize that this idea stands in tension with the teleonomic methodology of complex adaptive systems, but I will not interpret that tension as an implicit, neoliberal bias on Holling's part. The fact that Holling accounts for the resilience of social and ecological systems as something that human agents can reflexively change suggests that he does not believe that the adaptive cycle constitutes a totalizing, inescapable pattern. There are contradictions, to be sure, in Resilience theory, but those contradictions can be (and are) read in either reductionist or anti-reductionist registers. Chandler, a prominent proponent of resilience theory, vocally endorses Cillier's distinction

[108] See Angner, 2002, for a more thorough discussion on social Darwinism in Hayek's thinking. In addition to Hardin, the eugenicist, Alexander M. Carr-Saunders, author of *The Population Problem* (1922), was a significant inspiration for Hayek's theory of cultural evolution.

[109] Wiener suggested that economic models needed to be updated periodically to better reflect the changing social reality. Hayek, by extending the deterministic evolutionary logic of the servomechanism to the social reality itself, turns Wiener's theory on its head.

between general and restricted complexity, and he strongly encourages resilience thinkers to interpret resilience in a non-reductionist register. The problem is that both Chandler nor Holling struggle to make a clean break from the restricted worldview without the key distinction between teleonomy and teleodynamism that Rosen and Deacon provide. Once again, for both Rosen and Deacon, there is a recognition that teleodynamic systems both produce and make use of teleonomic systems, and it is through this lens that we can begin to re-interpret both Hayek and Holling.

To suggest, as Hayek does, that markets are "self-regulating" within the broader context of social laws and norms is nothing particularly radical (not since Smith, anyway), but the idea that the optimization-logic of the market extends to the contextualizing system that produces those laws and norms constitutes semiotic self-reference and the conflation of final cause with efficient cause. For Rosen, teleonomic self-organizing processes cannot constitute complex wholes. Rather, market production and allocation are both understood as metabolic processes that exist only in relation to the repair component (analogous to the care economy, healthcare, education, and sanitation), and the complex unity of the two together can be realized in an infinite number of non-equivalent forms. Once again, evolution appears as a "searching process", indeterminate yet constrained to be sure, but also fundamentally irreducible as an epiphenomenon of material causes or the rationalization of some more fundamental truth. For Hayek, by contrast, efficiency is the subconscious final-cause of evolution (like Spencer, Odum, Lotka, and Hardin before him). Through Holling, we might note that less "mature" ecosystems (i.e., R-phase ecosystems) are less efficient in terms of their resource usage than more mature (i.e. K-phase) ecosystems, much like smaller animals are less energetically efficient per unit of body mass compared to larger animals, but that should not suggest that larger animals and more interconnected ecosystems are more highly *evolved* than their less efficient counterparts. In fact, R-phase ecosystems exhibit higher adaptive capacity in large part due to a greater functional diversity that is lacking in more highly interconnected ecosystems. By appreciating and celebrating this unique quality in R-phase systems, Holling can be read as having countered not only the neoliberal fetishization of growth but also earlier attempts to appropriate R-K selection theory in support of nativism, eugenics, and anti-immigration politics. Although this point is generally lost, Holling's theory denaturalizes optimization-ontology by affirming ways of being that are not preoccupied with efficiency above all other ends.

Mikulecky and Coffman align Rosen and Panarchy by describing social and ecological collapse as a consequence of "monocultures of models" (Mikulecky and Coffman 2012). Rather than Holling, the authors point to Robert Ulanowicz's[110] concept of "centripetality" and ascendancy, which he describes as an alternative interpretation to both Maximum Empower and Holling's adaptive cycle (Ho and Ulanowicz 2005; Jørgensen et al. 2007; Ulanowicz 1986, 1997, 2004, 2009b). A core difference between Ulanowicz theory and Odum's maximum empower is that Ascendancy, like stability, is not a normative concept. Systems with high functional diversity are more pluralistic in that they contain more realizations of non-equivalent perspectives. One might say that they are "more" qualitatively complex, underscoring the key caveat that "thick" complexity is not measurable. ("More complex" in this sense is perhaps analogous to the observation that different interpretations of infinity in mathematics are more or less general than others, despite the fact that all infinities are irrational by definition). Systems with lower functional diversity are more complicated (i.e., "thin" algorithmically complex). They contain more interconnections between more types of components, but those components are all realizations of the same anticipatory regime: the dominant growth paradigm. Through this lens, we might infer that highly complicated systems become "brittle," "accidents waiting to happen" because they are myopic and semiotically impoverished. They cannibalize their capacity for adaptation and repair (their "care economies") whereupon the final cause of the system becomes indistinguishable from the efficient cause of autocatalytic growth at all costs. For Mikulecky and Coffman, the fact that ecosystems themselves seem to adopt a Hayekian logic means that ecosystems become *senescent* as they become more interconnected and complicated and not more "highly evolved."

How such a thing might occur is not so outlandish. If, as Rosen suggested, we entrain the world through the lens of situated "reality tunnels," then ultimately, most of our environment consists of the realizations of previous models. If we surround ourselves, for example, with computers, and if our interactions with one another are mediated by simulations, then is it any wonder that we begin to

[110] Ulanowicz's approach to theoretical ecology is decidedly constructivist he explicitly eschews both laws and determinism, preferring to describe regularities in ecosystems as either habits or propensities (following popper). His ontology follows Prigogine by affirming real aleatory in nature, and he describes his approach as "process ecology" (in the tradition of "process philosophy" including thinkers like Schelling, Bergsen, and Whitehead). Although he falls within the Odum tradition in systems ecology, he has sought to address many of the philosophical deficiencies of Odum's theory. In my view, Ulanowicz, along with James Kay, represents a more nuanced, responsible, and life-affirming extension of earlier, servomechanical systems ecology that is more amenable to constructivist environmental justice. Again, to counter Melgar-Melgar and Hall, I ask why we should "go back" to Odum when there are more sophisticated and inclusive theories available to us now?

imagine that we might exist within a simulation? In my view, however, the notion that such an evolutionary pattern of increasing semiotics self-reference might exist should not suggest to us that it is *inevitable*, particularly for systems that are reflexive in real time. In other words, if we are aware of such traps, perhaps we can avoid them (this point is implicit in Holling). On the other hand, it does not help that those with the most privilege and power to "name the world" are most often also the beneficiaries of the prevailing social ontology (something, I believe, that can be changed). Although they do not make the connection, Mikulecky and Coffman are essentially reifying the metaphor that Vandana Shiva makes in her essay, *Monocultures of the Mind* (Shiva 1993).

> Over and above rendering local knowledge invisible by declaring it non-existent or illegitimate, the dominant system also makes alternatives disappear by erasing and destroying the reality which they attempt to represent. The fragmented linearity of the dominant knowledge disrupts the integrations between systems. Local knowledge slips through the cracks of fragmentation. It is eclipsed along with the world to which it relates. Dominant scientific knowledge thus breeds a monoculture of the mind by making space for local alternatives disappear, very much like monocultures of introduced plant varieties leading to the displacement and destruction of local diversity. Dominant knowledge also destroys the very conditions for alternatives to exist, very much like the introduction of monocultures destroying the very conditions for diverse species to exist (Shiva, 1993, p. 4).

Some ecologists will no doubt take issue with the fact that, through this comparison of concepts, I am also subtly comparing venerable K-phase ecosystems to monocultures, and that is obviously a fair criticism. But I maintain, following Ulanowicz and Holling, that the two are minimally comparable insofar as the adaptive capacity of both is limited by their low functional diversity. Conversely, some social theorists may object to the reification of Shiva's metaphor, claiming correspondence between pluralism and functional diversity – as reminiscent of the "adaptation thinking" of cultural ecology and ecological anthropology. Here again, the distinction between complexity and complicatedness must be reiterated. Thick complexity is not cybernetic; it cannot be controlled or operationalized as a matter of novelty and requisite variety. Accordingly, I do not view pluralism as a resource that can be cultivated and deployed at will. Rather, the concept of complexity-as-plurality presented here is a matter of equifinality and pluripotentiality; the indeterminate and unprestatable; what Kauffman calls the "adjacent possible" (Kauffman 2008, 2016, 2019; Kauffman and Gare 2015). Although measurable, functional diversity is not the driving force; it is simply a measurable consequence of a more fundamental incompleteness, and,

therefore, pluripotentiality that characterizes r-phase ecosystems. Among other things, this perspective serves as firm counterpoint to Hardin's nativist claims that diversity must be restricted in the name of diversity itself.

Recalling Chapter 2 of this text, Hornborg protests that resilience is "conspicuously unclear" on whether "learning" in complex adaptive systems "is a matter of storing information as practically useful knowledge, rather than of mystically codifying 'wisdom' into the cybernetic structure of social organization" (Hornborg, 2009, p. 254). The distinction between thick and thin complexity is implicit in this question, and without it resilience thinkers cannot help but remain "conspicuously unclear" as to the onto-political implications of their claims. The result is pervasive uneasiness and occasional misappropriation by bad actors (which breeds more uneasiness). The only way to preserve complex adaptive systems against both criticism and misuse – in the sense that these ideas are being employed for purposes that run counter to their originally stated purposes - is to firmly articulate that this technical approach cannot be used to arrive at *objective* imputations for decision-making. We must be careful that we do not reify our simulations lest they become self-fulfilling prophecies.

5.3.3: Order and Disorder in Banfield's Broken Windows

Banfield's 1985 essay, *Policy Science as Metaphysical Madness,* warns of the dangers of "social science utopianism" whereby a growing class of technocratic social scientists threatens to displace politics and moral decision-making.

> It will always be impossible to construct a formal model that will be of use to policymakers when, as is invariably the case with the "important" problems, one cannot Identify all the crucial parameters or match them with adequate data. No one will ever find a technique for discovering the concrete implications of vague, contradictory, and fluctuating purposes. There is no logic by which one can pass from axiological principles to particular value judgments, and there can be no nonarbitrary way of finding the optimal terms of trade at the margin among government objectives when-as is always the case-they are not given to begin with. Finally there is no "objective" way of making correct probability judgments: some ways of making such judgments are surely better than others, but none can altogether exclude guesswork. Even if the policy scientist could know precisely what constitutes "good housing," "good schooling," and so on, he could not know (except in cases so obvious as not to need analysis) which policy alternative would yield the preferred

> set of consequences. In a world in which everything, including opinions as to what is preferable, is subject to rapid change, this limitation must be of enormous importance. Despite his claims to method and technique, the policy scientist must in all these matters make up his mind very much as the layman does and always has done.

Once again, this statement, in and of itself, bears many similar features to Rosen's theory of the modelling relation. The conclusions that Banfield draws from them, however, are distinctly anti-pluralist:

> …Indeed, the proliferation of policy science is making policy problems more numerous and complex. David Cohen and Janet Weiss show this in their review of the "torrent" of research done on schools and race since the Brown v. Board of Education decision. One study, they found, led to another that was more sophisticated, and then to still another, and so on. The quality of research improved as the process went on, but the outcome was usually not greater clarity about what to think or do, but, instead, a greater sense of complexity, a shifting in the terms of the problem, and more "mystifcation" in the interpretation of findings. "One thing is clear from this story," Cohen and Weiss conclude, "the more research on a social problem prospers, the harder it is for policymakers and courts to get the sort of guidance they often want: clear recommendations about what to do, or at least clear alternatives." At its best, they say, social research "provides a reasonable sense of the various ways a problem can be understood and a reasonable account of how solutions might be approached." Perhaps one is justified in concluding (as they do not) *that it is easily possible to have too much of a good thing: that an analytical society may increase its problems while decreasing its ability to cope with them.*

What are we to make of this claim considering my discussion on complexity? At first glance, this passage might be interpreted as suggesting that conservatives distrust the liberal consensus for what appears to be some of the same reasons that post-structuralists do, i.e., a distrust of technocratic optimism. Banfield recognizes that complicatedness - through objective science leading to increasingly granular command and control policy -is never commensurate with the infinitude of "thick" complexity. By contrast, liberal and neo-liberal consensus vis-à-vis objective policy science represents the generalization of a pervasive, teleonomic worldview that is encoded in economics and neo-Darwinian evolutionary theory. There are many forms of liberalism, but the dream of this particular version is that greater understanding will simplify complexity, thus affording us greater control. With greater control, it

is hoped that we can universalize our consensus and the prosperity it affords. Neoliberals, by contrast, seek what Farrell has termed “untrol”: the assertion of “control in the absence of normative intention” (Farrell 2020). Neoliberals do not seek to master teleonomy; they operate under the assumption that efficiency-optimizing teleonomic processes will achieve mastery *for* them since humans are not capable of constructing sufficiently complex social structures to achieve control on our own.

However, if we accept, as I do, that complexity is neither measurable nor computable, then another way of interpreting Banfield’s claim would be to suppose that our societies themselves do not become more complex, but rather, they often become more complicated, and, as a result of that complicatedness being inadequate in the face of the pluripotentiality of complexity, we ourselves only become increasingly aware of how much our previous models excluded, and, by extension, who those models did not serve. The conservative view, thus, conflates a greater *awareness* of complexity with "having more problems," and their solution, unsurprisingly, is to equate shutting one’s eyes with having fewer problems. Again, the subtle, discursive practice of conflating thick and thin complexity generates wholly different ontopolitical imputations. Banfield endorses enforcing a smaller consensus by drawing a circle within complexity and agreeing to unmoor anything that lies beyond. In other words, de-pluralization. Incidentally, Banfield was close contemporaries with conservative economists such as Frank Knight, Goerge Stigler and Milton Friedman. A deeply controversial urbanologist, Banfield is perhaps best known as the progenitor of the profoundly racist “broken window” policing policies – predating, but made infamous by, Rudy Giuliani - that continue to affect the targeted marginalization of inner city marginalized populations in the United States. The idea was that minor offences, such as graffiti, minor drug offences (even “loose” cigarettes), and petty vandalism, create a pervasive atmosphere of lawlessness that feeds back to create more rampant lawlessness. The potential for crimes not yet committed was used, and is still used, as a pretense for both excessive judicial sentencing and extrajudicial police brutality across the United States.

Cornel West has long grappled with the tensions inherent to concepts of holism in relation to the systematic marginalization of Black communities. Although he eschews functionalist concepts of societies as integrated ‘totalities”, he nonetheless argues in favour of heuristic, non-ontological approaches to understanding interrelationality: “Without "totality," our politics become emaciated, our politics become dispersed, our politics become nothing but existential rebellion. Some heuristic (rather than ontological) notion of totality is in fact, necessary if we are to talk about mediations, interrelations, interdependencies, about totalizing forces in the world. In other words, a measure of synecdochical

thinking must be pre-served, thinking that would still invoke relations of parts to the whole ... It is true, on the other hand, that we can no longer hang on to crude orthodox "totalities" such as the idea of superstructure and base" (West, as interviewed in Stephanson, 1989, p. 270). Considering Banfield as well as many other examples of the ways in which ontological holism has been weaponized as an instrument of oppression, West's assertion that a counter-active concept of holism must be heuristic and pragmatic rather than ontological is certainly understandable. And yet, the recent "ontological turn" in political theory is partially predicated on questioning whether such heuristic approaches can unseat the decidedly ossified, implicitly functionalist ontology of techno-capitalism that dominates human affairs. Following Connolly, the relational-ontological holism of Deacon and Rosen provides the means for both furthering our understanding of the complexity of integrated wholes whilst counter-acting the functionalist determinism that has dominated organic thinking since its inception and continues to proliferate in the policies of Banfield and many others.

What does it mean to break a window? For many, it is an expression of subversion against domination and dehumanization. It spells resistance and rage in the face of institutionalized racism and political and economic exclusion brought about by the segregation of marginalized peoples in the physical and mental constructs of low-income "development". By disrupting the portals between structures and everything they do not contain, a broken window destabilizes the physical realizations of semiotic structures within which pervasive power relations are implicitly codified. The complexity of difference flows freely through broken windows. By subtly conflating "a sense of the various ways a problem can be understood" with an "increase of problems", Banfield thereby conflates civic unrest - the yearning for a new order that is struggling to be born - with *dis-order*. The difference between "street art" and "public defacement" tells us that once drawn, artificial boundaries within complex reality must be constantly reinforced through physical, political, spiritual, and epistemological violence. For the anti-pluralist, a broken window is the gravest of crimes (see Figure 14).

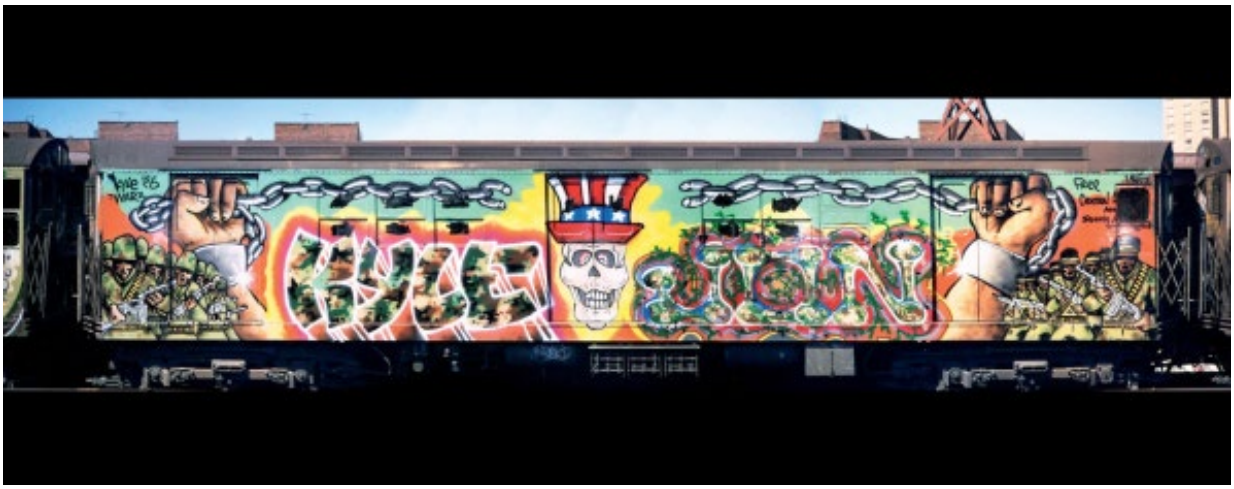

Figure 13: Street art as resistance. Painting by *Jon One, 1970's NYC. Photograph by Henry Chalfant (image source:* Dunne, 2014)

The pluralist impulse is *to affirm* complexity by affirming the pluralization of non-equivalent ways of being, seeing, and knowing. In doing so, we recognize that we were never dealing with "problems" per se, but only the natural consequences of excluded perspectives and the potentials that they engender. Connolly describes the “ethos of pluralization” as a matter of “staying with the possibilities” (a subtle alternative to Haraway’s “staying with the trouble” (Haraway 2016)), and in this, he recognizes that ways of being, seeing, and knowing are not static; perspectives are processes with potentials: ways of becoming, interpreting, and thinking. It is also the freedom to both dissolve and reform new constitutive relations. Pluralization necessarily implies resisting exploitation and domination – the co-optation of the potentials of others – as anti-pluralist by definition and, as that which necessarily delimits the adjacent possible. The radical democratic orientation thus does not emphasize pluralization for the purposes of untrol or control; it does not seek to operationalize pluralism for the maintenance and regulation of the current social-organizational mode. Radical democracy, rather, seeks to cultivate pluralism because it creates possibilities for new political and identity formations and organizational modes that we would otherwise be cut off from under paradigms of control or untrol.

Once again, the process of agonistic democracy is not perfect, and it is never complete, nor does it imply that all windows everywhere ought to be broken at all times. This is a tension that was always implicit in second-order cybernetics and will continue to be relevant; the potential for new structures is realized through the selective application of constraints, and it is necessary to remove or configure constraints to realize potentials. Structure, stability, and regularity cannot coalesce in underdetermined systems, and

conversely, over-determined systems represent the highest potential of a given regime of constraints, but they will eventually fail due to myopathy because there is always *something* the regime could not have anticipated (even, in extreme cases, asteroids or catastrophic geological events). In other words, systems do not collapse because they become too complex, rather, they either implode under the infinitude of the potentialities they neglect, or they lose cohesion when all potentialities become equally possible. Within this conceptual frame, the insight of radical democracy -with its emphasis on pluripotentiality and difference - translates into the recognition that there is no static, optimal point that a system might occupy on this spectrum, and so it is necessary to perpetually oscillate between the extremes without straying to either extreme. To do this, we must preserve contestation against consensus to prevent myopathy, but we must also seek to sublimate violence to prevent antagony.

By way of summary, I have not proposed my own unique theory, but I have offered a patchwork of theories that do not violate one another, from disparate sources, to demonstrate one way in which this might be done. We need theories such as, but by no means limited to, the sort that I have cobbled together here so that natural scientists can engage with social reality, and so social theorists can engage with the constraints imposed by biophysical reality. But I do not wish to suggest that Mikulecky and Coffman's biosemiotic and Rosennean re-interpretation of the adaptive cycle is the *only* conclusion we might draw from the distinction between teleonomy and teleodynamism. Rather, I have offered it as a sketch – one that I find compelling and others might not – of what one approach to ecological political economy might look like. I offer this perspective to *supplement* what I see as a rich tradition of scholarship that occupies the space I am trying to contribute to. Ecological political economy, as I see it, includes Kay's ecosystem approach (Kay and Regier 2000; Waltner-Toews, Kay, and Lister 1999); multi-scale integrated analysis of societal and ecological metabolism (Giampietro et al. 2014; Giampietro, Mayumi, and Sorman 2012; Giampietro and Mayumi 2000; Kovacic and Giampietro 2015; Silva-Macher and Farrell 2014); bioeconomics (Farrell 2007, 2009; Farrell and Mayumi 2009; Georgescu-Roegen 1971; Mayumi 1997); relational values (Himes and Muraca 2018); as well as key insights from ecological economics (Faber et al. 1995; Faber, Petersen, and Schiller 2002), political ecology (Hornborg 2017c, 2017a; Persson et al. 2018), theoretical ecology (Matutinović, Salthe, and Ulanowicz 2016), and speculative naturalist philosophy (Gare 2008, 2013; Stengers 2011). What many of these approaches have in common is that they operationalize select methods of thin complexity in tandem with agency-affirming insights from theoretical ecology to *counter* technological fetishism and technocratic optimism concurrently. They also all recognize and affirm the non-equivalence of causal categories.

By reconceptualizing living systems as teleodynamic systems we not only counter the bifurcation of nature (Whitehead, 1978 [1929]), but we also turn functionalist, progressive evolutionism upside down. For decades, many social theorists have looked to ecology and biology for naturalizing metaphors, but a teleodynamic view of life, on the other hand, imparts the human capacities for anticipation and creativity to the natural world. Are ecosystems conscious? Perhaps not, but I would venture that creativity is rarely a matter of purely conscious thought[111]. Ecological systems may appear teleonomic to us, perhaps only because ecological reflexivity occurs over much greater temporal and spatial horizons. Moreover, by recasting living systems as systems of reflexive meaning-making, we can recover these possibilities for ourselves as well (this was, I think, Rosen's intent). That is, if we can discern patterns like adaptive cycles in both social and ecological systems, then perhaps there is no need for us to be passive participants in those cycles as well. Ultimately, the complexity of difference reinstates the human agent with purpose and responsibility for our choices.

[111] I think of the choice and creativity involved in the encoding step of the modelling relation as akin to what Peirce calls "firstness", but I cannot explicate on that argument to any satisfactory degree in this text. Instead, it is worth noting that Rosen's thinking has experienced a recent renaissance in the field of biosemiotics where these subjects are discussed at length.

Chapter 6: Realizing Ecological Political Economy

"Seek simplicity and distrust it." – A.N. Whitehead

6.1: The Value of Thin Complexity

Although I describe teleonomic approaches to complexity as "thin" approaches, I do not mean that in any pejorative sense. Ultimately the importance of the distinction is to prevent organic systems from being confused with machines. But the problem with complex adaptive systems is the same problem that plagued general system theory (and, I would surmise, this might be extended to all forms of structural or functional analysis): it uses mechanistic modelling tools because there is no other way to model. Scientific modelling, by its nature, is mechanistic, and insofar as we are interested in knowing what will happen next and why, modellers cannot help but be reductionists. At best, modellers can be "pragmatic reductionists" ("all models are wrong") with both a sense of respect and awareness of what that entails.

What does that imply for the potential "usefulness" of teleonomic systems modelling approaches? That depends. Under a regime of ontological reductionism where there is an implicit correspondence theory of truth, these models become distinctly unhelpful because ontological reductionism cannot accommodate teleodynamism, and so these models become explanatorily self-referential. However, under a regime of "pragmatic reductionism", these models gain extraordinary *descriptive* power because, following Deacon, teleodynamic systems *rely on* the very teleonomic processes that constrain them[112]. "Thin" complexity can, therefore, tell us a great deal about *constraints* that teleodynamic systems are subject to. Once again, this relates to the old distinction, from cultural ecology, between "environmentalism" (i.e., environmental determinism) and *possibilism* (see Chapter 3). Thin complexity, by simulating the teleonomic processes that serve as "facilitative constraints" for teleodynamic systems, works in the negative register by determining what a given system is *unable to do given the means at its disposal*. I assert that these distinctions, if you know to look for them, are often already implicit in complex adaptive systems research. Peterson, who is a frequent interlocutor in debates between

[112] Howard Pattee, who was a close colleague of Rosen's, described such processes as "facilitative constraints". These themes are also explored by Salthe. A discussion on these topics, although they are certainly relevant, falls far beyond the limited scope of the current text.

resilience thinking and political ecology, consistently notes that scenario analysis is not a matter of what the system will do but rather what a system *can do* or *might do.* In that regard, the Planetary Boundaries study by Rockstrom et al. (figure 15) is an example of the extraordinary potential of "thin" complexity. It is also noteworthy that social theorists do not object to the findings of the planetary boundaries framework when they object to the same theorists discussing the "Anthropocene." I submit that this is because they recognize the limited self-organizing capacity of various earth systems processes when compared to the holistic and fatalistic implications of concepts like the *Anthropos* that speak to the anti-humanism of totalizing, holistic concepts of humanity and human nature.

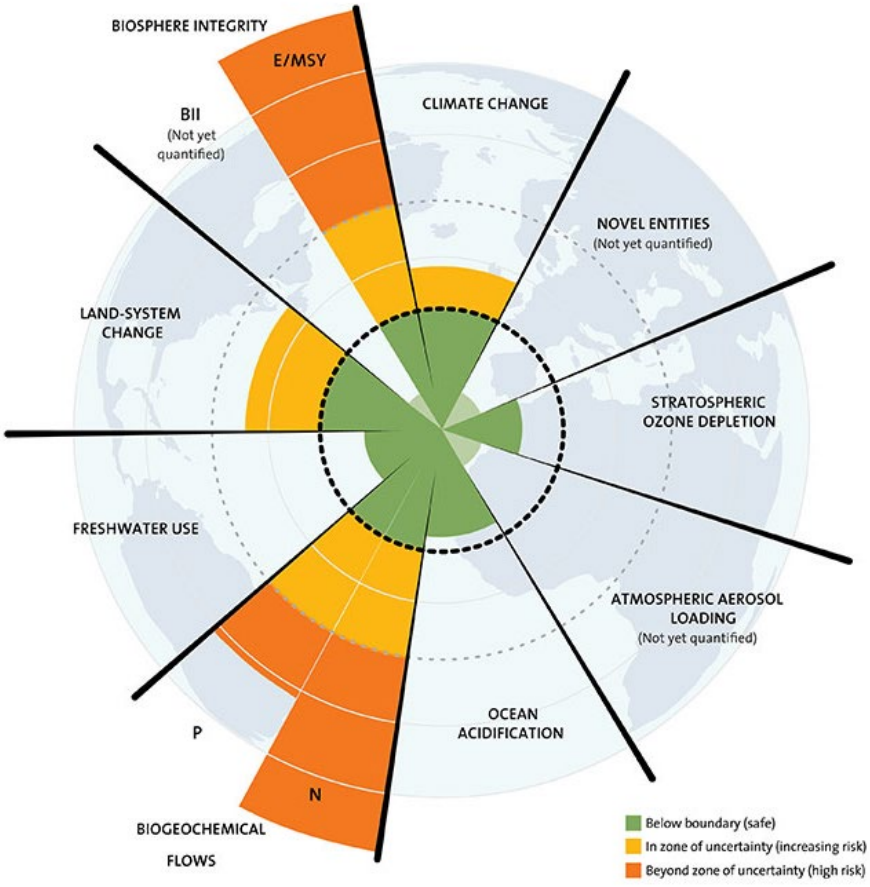

Figure 14: Planetary Boundaries (Rockstrom et al. 2009)

For Machin, unlike Costanza, complex problems are precisely the sorts of problems we *should* disagree on because we cannot, in principle, avoid doing so. There is no "world we all want," as Costanza suggests, but there are certainly possible worlds that we all *do not* want, and we only need to peruse geological history to clarify this point (figure 16). As we work our way backwards from thick complexity and post-

normal science, we begin to see that many of the constraints we face pertain to merely complicated processes. Despite the nonlinearities and uncertainties involved, there is nothing complex - in the "thick," teleodynamic sense of the term - about the physical processes that lead to global warming, but the *climate crisis* that it engenders – i.e., how a warming climate will interact with the infinite plurality of human and non-human, biotic and abiotic self-organizing processes present on Earth - is profoundly complex. Thus, in light of Machin and Farrell (2020), I submit that the distinction between complicatedness and complexity can help us to distinguish legitimate political contestation from extremism by helping us to distinguish "post-normal" from "post-truth".

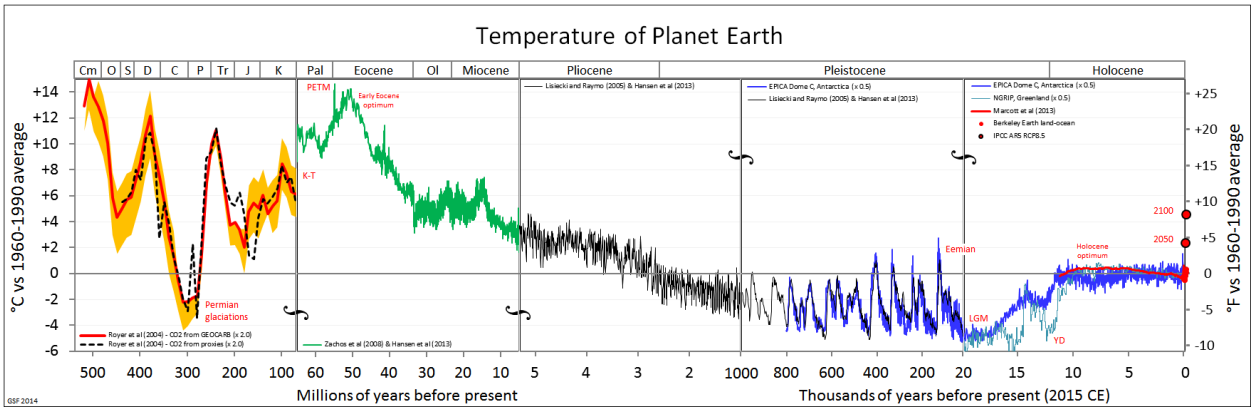

Figure 15: The red line a the end of the graph represents the last 11,650 years: the Holocene (image source: Stiepani, 2016).

All these themes played out writ large during the (still ongoing) COVID-19 pandemic that has claimed millions of lives globally and has exacerbated the inequality between the ultra-rich and poor to an unprecedented extent. To any reader who might suggest that this text's preoccupation with social Darwinism is a case of "beating a dead horse," I point to the pandemic as a strong indication that not only is that "horse" still very much alive and kicking, but it also more agitated now than it ever has been. Millions of "anti-vaxxers" proclaimed their alleged physical and racial superiority that allowed them to endure the virus without consequence (even as scores of them died from a virus that *uses* its host's "healthy immune system" – vis-à-vis autocatalytic cytokine release - to kill them). Those who died were characterized as "weak" due to pre-existing conditions, and, therefore, their deaths were cast as both "natural" and unavoidable. There is a growing trend of hospital patients refusing blood transfusions - even when they are terminally ill – without a guarantee that they are receiving "pure blood" from unvaccinated donors.

Conversely, the liberal consensus translated into a vaccine mandate, whereby the unvaccinated were sometimes portrayed as having "de-selected" themselves through sheer ignorance or susceptibility to anti-science propaganda. Although these quips were generally directed at anti-science radical conservatives, these claims take on racist overtones when one considers the high levels of vaccine hesitancy in minoritized populations who not only currently experience higher rates of institutional medical abuse and negligence but also have historically been victimized through non-consensual medical experimentation (e.g., the Tuskegee vaccine trials). The history of the COVID-19 pandemic can be read as the legacy of eugenics in conversation with itself.

Incidentally, one of the most exceptionally effective use cases for cellular-automata is in modelling the ways viral contagions spread through populations, and, by and large, the predictions made by public health researchers throughout the pandemic have proven remarkably accurate. Using these methods, public health researchers proved instrumental in crafting public policy that proved highly effective in mitigating the spread of the contagion. In multiple instances, however, modellers have faced backlash, censorship, and legal or even physical intimidation by hostile state authorities with an economic interest in suppressing any pretense of restrictions. In some countries and regions, evidence-based public health policy proved highly effective in containing or mitigating the pandemic long before vaccines were made available. In other regions, the very possibility of vaccines was used as a pretense to ignore potentially effective policy options in the short term, and the long-term impacts of these decisions may result in greater costs in human suffering consequently. For example, while there is some evidence to suggest that vaccines may help mitigate post-COVID syndrome, they do not prevent it entirely, and public health researchers now warn of an impending echo-pandemic of chronic illness as a consequence of policymakers relying on technological interventions over prevention and mitigation[113]. In many cases, these and other serious consequences might have been avoided if more comprehensive, preventative policies, such as those recommended by many public health officials across the world, had been adopted earlier. Instead, we have witnessed the waning influence, if not outright vilification, of expert scientists in the face of global catastrophe. The oppressive technocratic utopianism that Banfield warned of never materialized.

The COVID-19 pandemic, thus, appears as yet another "Giddens Paradox" that parallels that of climate change and the sustainability crisis. In both cases, expert scientists are consistently overmatched by technological fetishism, neoliberalism, and illiberalism. Given the circumstances, it is certainly

[113] This issue parallels the long-standing "mitigation versus adaptation" debate in the climate change discourse.

understandable that many expert scientists might adopt a posture of technocratic optimism in an attempt to forcefully assert their very tangible concerns. However, as I have argued, this tactic is self-defeating because technocratic optimism, technological fetishism, neoliberalism, and illiberalism are all both competing and codependent expressions of the same pervasive social Darwinism; what Farrell calls "untrol". Technocratic optimism, thus, cannot resist these forces without implicitly validating and reinforcing the underlying logic that animates them. Even if it could, technocrats are simply outmatched in this struggle of ideologies; the imaginaries of bureaucratic order have no hope of competing with the childlike escapism of futurists, the grandeur of unimaginable greed, or the blinding rage of resentment and bigotry. Technocratic optimism, however, can and does serve as a powerful instrument for all those forces, which is another reason it should be abandoned.

Machin suggests that the way to diffuse this corrosive dynamic is for expert scientists to adopt a more modest position by abandoning the pretense of technocratic optimism – i.e., the possibility that science can objectively displace politics - altogether. Following Cilliers and Farrell, I have attempted to demonstrate how such "modest" positions are also stronger positions for expert scientists in their roles as knowledge producers for decision-making. To that end, I have attempted to extend both Machin and Farrell's insights by identifying and disrupting some of the discursive objects that technocratic optimism relies upon in key discourses within sustainability science (namely, ecological economics and social-ecological systems theory). In doing so, I have also attempted to destabilize the lines through which illiberalism, neoliberalism, and technological fetishism draw validation from theoretical ecology and systems theory.

To achieve this end, I have not attempted to defend or redeem systems theory so much as recontextualize it. By my account, systems and cybernetics represented attempts to realize a new scientific paradigm grounded in the relational ontology of emergentism, but they were ultimately limited by the methodological tools at their disposal. There were subversive elements, but there were also conservative and regulative elements (e.g., Casti's co-optation and re-interpretation or Rosennean complexity), and those two forces displayed a remarkable symmetry between the relational holists and the reductionist functionalists (e.g., Wiener and von Neumann; Boulding and Odum; Bertalanffy and Forrester). In some cases, I have sided with the critics (e.g., Peter Taylor's critique of Odum), and in other cases, I have criticized the critics (e.g., Walker's critique of Holling or Sagoff's critique of theoretical science altogether). In doing the latter, my interest was in preserving the subversive impulse in systems theory where it existed

and preventing the concession of key thinkers to hegemonic forces where their ideas might otherwise be put to better use in the service of environmental justice and sustainability concurrently.

From the preceding discussions, I have concluded that in order to be a truly pluralistic transdiscipline, ecological political economy must be attentive to the following points:

- The recognition that many different processes exhibit "differential capacities of self-organization" (Connolly, 2013, p. 9). These processes can and do interact in many ways, but, since it seems to be impossible to establish a single, complete, consistent, and universally accepted formal logic of how self-organization occurs, we should operate under the assumption that there is no single, pervasive logic of self-organization that all processes – social, biological, psychological, and otherwise – conform to.
- A recognition of the non-equivalence of causal categories and the interactions between them. Causal categories interact in myriad ways, but they cannot be reduced to one another.
- A distinction between teleology, teleonomy, and teleodynamism.
- An indeterminate ontology that also recognizes the regularity imposed by constraints.
- A fallibilist epistemology that can usefully engage pragmatic holism and pragmatic reductionism (i.e., entangled humanism in Conolly's terms).
- An anti-deterministic, non-progressive concept of evolution.
- A relational concept of ontological holism in which wholes are both incomplete and unknowable in their totality.

This approach accommodates political ecologists by precluding environmental, genetic, and biological determinism. Uniquely, it accommodates holists and even organicists but not structural functionalism. It upholds the core critique of biophysical economics by insisting that material cause cannot be ignored or subsumed under efficient or formal cause (as neoclassical economics does), but it also constrains the biophysicists by reminding them that a reduction of formal and final cause to material and efficient cause (i.e., physicalist reductionism) is an equally pernicious form of biophysical economism. This list is not exhaustive; it is meant to be adapted, refined, and added to. Furthermore, there are many ways to arrive at similar, or perhaps even more useful, conclusions that do not follow the paths I have chosen. I also firmly believe that many researchers implicitly operate under similar assumptions already. One of the purposes of this intervention is to provide researchers with some theoretical distinctions and boundaries that they might use to defend themselves against undue criticism while at the same time providing critics with conceptual tools to help identify when hazardous lines are being crossed.

6.2: The End

If researchers intend to use the concept of complexity to facilitate pluralism and transdisciplinary exchange between sustainability science and environmental justice, then it must be understood that thin complexity can be operationalized within a broader framework of thick complexity, but not the other way around. Unless researchers first draw a firm distinction between thick and thin complexity, it will not be possible to know which side of that line they fall on.

By rendering the idea of the penumbra as impenetrable as the penumbra itself, we lend to it an inescapable quality, one that makes it impossible to say not only what we can expect to encounter within but also that which we should reasonably hope to emerge from it having obtained. Does complexity obscure that which was there prior: certainty and meaning, faith in God, Laplace and his daemon? Can we enter this cloud and find clues as to where those beasts have gone in the hopes of finding them once more? Or does it transfigure the contents within? What will become of us, having now begun to traverse its bounds? I don't know, but I suspect we all have a better chance of navigating these challenges if we learn to find ways to work together despite not necessarily agreeing with one another. The complexity surrounding complexity fosters distrust and undermines agonistic respect and presumptive generosity. As I have argued, this does not need to be so. To that end, I have attempted to unify a number of disparate concepts of "thick" complexity under a single explanatory framework - Rosen's relational complexity – to provide some markers that might help us orient ourselves. It's not a compass, but it will have to do.

Rosen's four markers are as follows: complexity engenders *conflict*; complexity is not *computable*; complexity is *life*, and; complexity requires *care*. Following Rosen, Cilliers, Farrell, Machin, Connolly, and Deacon, I have argued in favour of an organic view of life, societies, and ecosystems that resists determinism, progressive evolutionism, and the displacement of politics. Some might object that this constitutes a theory of social organisms, but I would counter that a process-relational perspective more accurately reflects a theory that posits the opposite: organisms as societies (see Stengers, 2011; Whitehead, 1958 [1938]). Regardless, what I am suggesting is that organisms, societies, and ecosystems are all complex systems, and that complexity cannot be divorced from the concept of life. Organisms, societies, and ecosystems are all "living systems" insofar as they all realize relations of metabolism and repair. As such, they cannot be understood in purely physical terms, and their descriptions cannot be captured in purely reactive, mechanistic terms. Historically, the core problem with the concept of the

social organism did not stem from the fact that we were thinking of societies as organisms, the problem was that we were thinking of organisms as machines, and so our functionalist social theories were accordingly mechanistic. Even the concept of "function" is not inherently functionalist because function, in biology, is incoherent without a concept of purpose, which suggests a concept of agency. Naturalists robbed function of purpose because they were seeking to rob deistic teleology of agency. The collateral damage was that humans and nature were also robbed of agency. Life, according to Rosen, is incoherent within a mechanistic paradigm. It is elusive because life realizes relations that are impossible to formalize, and so we cannot "prove" that life exists using the means we use to prove non-complex phenomena. Following Connolly, I have argued that we must abandon mechanistic conceits in favour of "entangled humanism."

This presents an opportunity that looks at first like a problem: how do we care for that which cannot be demonstrated to have integrity? We'll never prove the autopoietic unity of ecological entities through simulation models, and we shouldn't try lest we confuse our simulations with life itself. For eco-modernists like Sagoff (2013), the fact that we cannot prove that ecosystems are living entities suggests that we ought not to concern ourselves with protecting them. But this view is not tenable because human life is also implicated in this dilemma. Following Salthe, "if our observations had the same scale relations to an organism as they have with respect to most ecosystems of biome size, we would not suppose an organism to be an individual either" (Salthe 2003). In Whitehead's terms, this presents a "performative contradiction": if we refuse to attribute holism to complex whole entities in nature because we cannot prove to the standard of Sagoff's "superannuated positivism"[114], then we must also refuse it ourselves, and we cannot deny our experience as living entities by virtue of our having to be living entities in order to deny ourselves as such. The fact that we attempt to do both of these things is perhaps a testament to the nihilism of techno-capitalism and late modernity: "At this hour, most Westerners have a life that is far more civilized than it used to be: solitary, rich, nasty, brutish, and long" (Weber, 2009, p. 123). Much like Mikulecky and Coffman suggest that societies may become convinced of their own teleonomy, untrol is that which makes it possible to surrender our own humanity by way of dehumanizing others. "Cyborg love means never having to say you're sorry" (Mirowski, 2002, p. 9).

And yet, as Connolly reminds us, this dilemma also presents a possibility of recovering humanity and personhood by recognizing that incompleteness is essential to being whole. When the only truth we

[114] See Donhauser, 2017 for an exceptionally strong critique of Sagoff's many claims against theoretical ecology.

know for certain is that we cannot know anything for certain, then agonistic respect (Schoolman 2002) and epistemological solidarity (Farrell 2020) are, in fact, the most objective positions we can hope for. One remarkable feature of the Gödelean argument is *that it uses the logic of formalization to demonstrate the limits of formalization;* the mechanism ultimately defeats itself. Among other things, this is important because we find ourselves in need of non-reductionist, non-functionalist concepts of "wholes" if we are going to make tractable arguments that ecosystems are worthy of the sorts of legal protections that we afford to other forms of life, and we cannot currently make these arguments in a way that is tractable within the pervasive paradigm of analytical jurisprudence and legal positivism. As ever, Gödel provided an argument that positivism *must* respect. Thinkers like Prigogine, Rosen, and Whitehead, aware of the opportunities the Gödel's proof created, forced open the door to teleodynamism. We cannot force anyone to cross that threshold, nor can we coerce them to accept what those thinkers saw beyond. But the door cannot be closed either.

This brings us to the end, which is fitting since that is where we began. There is much to be learned at the ends of things. At the end of Rosen's book, *Anticipatory Systems* (2012 [1985]), he remarks, "The identification of oneself with one's models explains, perhaps, why human beings are so often willing to die; i.e. to suffer biological extinction, rather than change their models, and why suicide is so often, and so paradoxically, an ultimate act of self-preservation" (p. 370). This means that the models we construct and the models that we ourselves are the realizations of, and the models that are realized when we entrain the world in the image of how we understand it, are constitutive relations, interdependent ways of being, seeing, and knowing. To dissolve these relations is a profound act of concurrent becoming and unbecoming that is traumatic for the self, even, or especially, when it is necessary. What does this tell us about the "end" that Hans Timmermans warned about at the beginning of this text; why is it easier, as Žižek has intoned, to imagine the end of the world than the end of the economic system that is causing it?

Rosen was fond of the following line that appears near the end of the George Bernard Shaw play, *Major Barbara:*

"You have learnt something. That always feels at first as if you had lost something."

This feeling of loss is the experience of vulnerability that accompanies a sudden awareness of the infinitude of our own incompleteness. It underscores Arendt's assertion that thinking is an intrinsically moral activity: "The manifestation of the wind of thought is not knowledge; it is the ability to tell right

from wrong, beautiful from ugly. And this, at the rare moments when the stakes are on the table, may indeed prevent catastrophes, at least for the self" (Arendt, 1971, p. 191). For Arendt, the process of thinking is a process in which frozen concepts are continually unfrozen and revisited; it is the infinite iteration of the modelling relation; the wheel that never ends unless we choose to stop it. The ability to tell right from wrong is not the ability to arrive at an ultimate transcendent truth, nor does it lie in surrendering in the face of our inability to find one. It is in our refusal to be told when we ought to stop this process, but also our capacity to *choose* when to take a stand, whereby we are responsible for our decisions and their consequences. As Arendt would have it, determinism – untrol - is the emotional refuge of one who cannot live with what they have done. Accordingly, untrol is that which serves to alienate ourselves *from* ourselves so we do not need to be accountable to ourselves: "Conscience Is the anticipation of the fellow who awaits you if and when you come home" (Arendt, 1971, p. 191). The only way to avoid that fellow is to become *complete* without him, and following Rosen, the only way to become complete is to become mentally self-referential. In doing so, we are no longer whole, and we are unable to fathom the processes that we have become mere mechanisms within. I think Arendt was suggesting that this is how catastrophes occur.

In the early days of ecological economics, Herman Daly published an edited volume on the Steady State economy, and the final chapter was C.S. Lewis' famous essay, *The Abolition of Man* (Daly 1973; Lewis 1943). Throughout that essay, Lewis reminds us that "Man's power over nature turns out to be a power exercised by some men over other men with nature as its instrument" (p. 29). Ultimately, to argue that it is our nature to conquer nature is to simultaneously render ourselves both the triumphant general and the prisoner walking behind the parade car. Our final victory over nature is the abolition of ourselves, of that which makes us human. Daly's inclusion of this essay was prescient in that it bears the imputation of a distinctly anti-reductionist, ecological political economy that had begun with thinkers like Georgescu-Roegen and Boulding. Theirs was not a legacy of biophysical economism, but rather the "narrow path" of entangled humanism; an ontology of becoming within a universe of constraints, both material and semiological. It is not an easy or rewarding path; it is what Barry and Farrell have called "the epistemological no-man's land," and one is liable to be shot by troopers on either side if taken as a hostile presence. Staying the course means "staying with the trouble" (Haraway 2016) and staying with the possibilities in equal measure. Many scholars still walk this path - I have attempted to include as many as I can in this text – and those that do know the consequences of stumbling from relationality into realism or relativism.

Lewis, like Arendt, ends his essay with a reflection on the moral dimension of how we think about nature and our place within it: “to see through all things is not the same as to see.” “The whole point of seeing through something is to see something through it. It is good that the window should be transparent, because the street or garden beyond it is opaque” (p. 40). What is the nature of a garden in parallax? What does it mean to break a window?

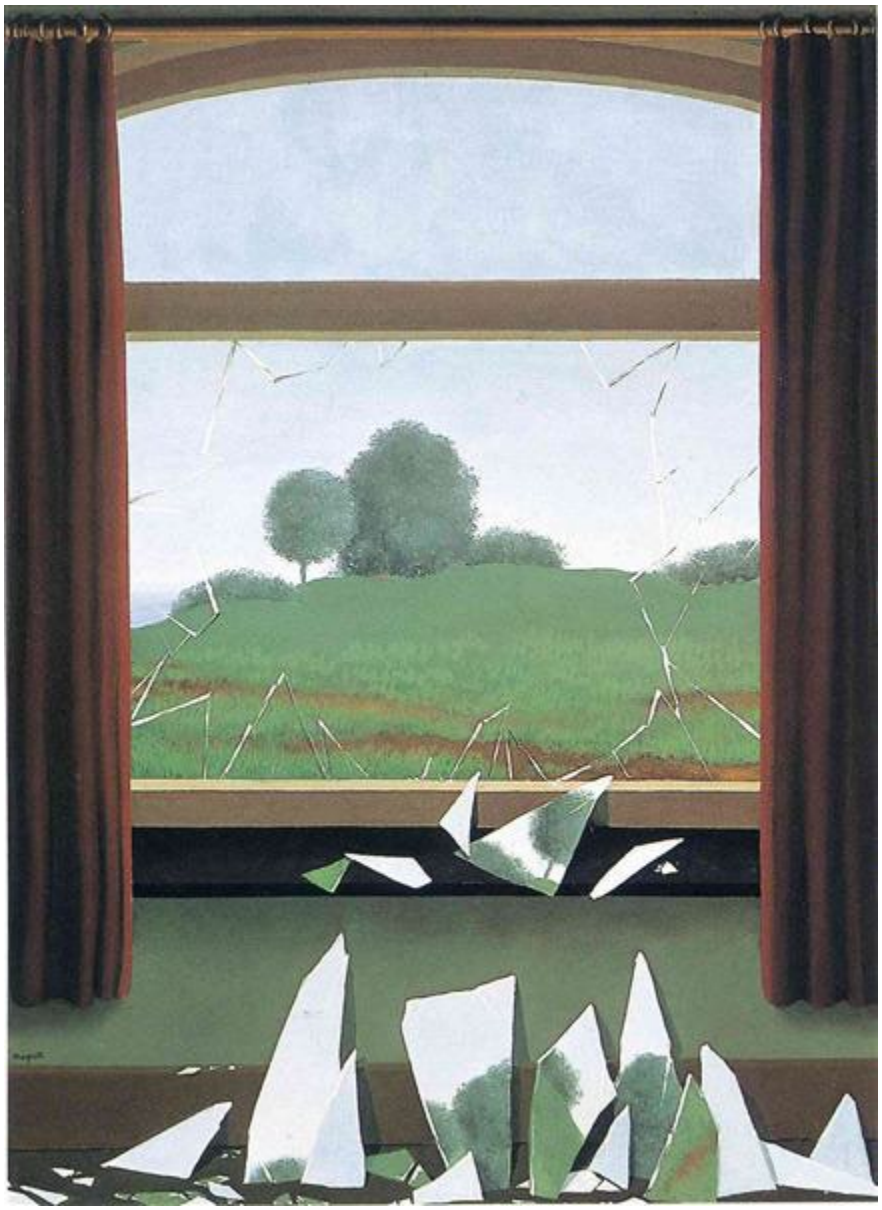

Figure 16*: The Key to the Fields. Rene Magritte: 1936, Brussels, Belgium.*

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