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Anti-Authoritarian Metrics: Recursivity as a strategy for post-capitalism

*Métricas anti-autoritarias:
recursividad como una estrategia
para el post-capitalismo*

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ABSTRACT

This essay proposes that those seeking to build counter-power institutions and communities learn to think in terms of what I call “recursivity.” Recursivity is an anti-authoritarian metric that helps bring about a sensitivity to feedback loops at multiple levels of organization. I begin by describing how technological systems and the socio-economic order co-constitute one-another around efficiency metrics. I then go on to define recursivity as social conditions that contain within them all of the parts and practices for their maturation and expansion, and show how organizations that demonstrate recursivity, like the historical English commons, have been marginalized or destroyed all together. Finally, I show how the

ownership of property is inherently antithetical to the closed loops of recursivity. All of this is bookended by a study of urban planning's recursive beginning.

KEYWORDS

Efficiency; counter-power; organizational design; rationalization; recursion.

RESUMEN

Este artículo propone pensar en la construcción de instituciones y comunidades de contrapoder a partir del concepto que denomino "recursividad". Recursividad es una métrica antiautoritaria que contribuye a la percepción de los bucles de retroalimentación del valor social en diferentes niveles organizativos. En el texto, comienzo por describir cómo los sistemas tecnológicos y el orden socioeconómico se co-constituyen mutuamente en torno a métricas de eficiencia. Después, paso a definir la recursividad como las condiciones sociales que contienen en su interior todos los elementos necesarios para su maduración y expansión. Asimismo, muestro cómo todas las organizaciones dotadas de recursividad, como los históricos *commons* ingleses, han sido marginadas o destruidas. Por último, me enfoco en cómo el principio de la propiedad privada de los bienes de producción es inherentemente antitética a los circuitos cerrados de recursividad. Todo el artículo está enfocado hacia el estudio de planificación urbana desde principios recursivos.

PALABRAS CLAVE

Eficiencia; contrapoder; diseño organizacional; racionalización; recursividad.

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You must come to it alone, and naked, as the child comes into the world, into his future, without any past, without any property, wholly dependent on other people for his life. You cannot take what you have not given, and you must give yourself. You cannot buy the Revolution. You cannot make the Revolution. You can only be the Revolution. It is in your spirit, or it is nowhere.

Shevek in Ursula K. Le Guin's *The Dispossessed* (1974)

1. False starts at the beginning of modern capitalism

Just before the turn of the twentieth century there was a young stenographer in London that was determined to invent something that would put him in the history books. He had tinkered and built several unprofitable inventions and even attempted to homestead in what would become the American state of Nebraska, but returned to London poorer in cash. He was however richer in questions, the biggest of which he called “the Social Question” and it plagued him for years after leaving the United States. Why, he wondered, were there poor people? Was it a matter of scarce resources or, perhaps, was it too hard to allocate needed goods and services when and where they were needed? This concern for the poor led him to a reading group of similarly minded people versed in all the great (male) authors of the day: John Stewart Mill, Charles Darwin, Thomas Henry Huxley, and Herbert Spencer among others. They rejected Marxist class revolution as too violent to be constructive and believed that ending poverty was possible within their lifetimes if someone could make a radical but pragmatic agenda out of the ideas they were discussing.

The stenographer-cum-radical philosopher and his compatriots eventually turned to “utopian romances”, a popular science fiction subgenre of the time, for inspiration. Utopian romances described far off futures where people achieved total self-actualization in perfectly planned and administered societies. In particular Edward Bellamy's *Looking Backwards* published in 1888 grabbed their imagination. It told of massive and complex supply systems that delivered the world's resources to the population in equal proportion. The stenographer was enraptured by the idea, but quickly realized that those who controlled the supply chain would have an inordinate amount of power compared to everyone else. He had read anarchists like Joseph Proudhon and Pytor Kropotkin and knew that where there was hierarchy, exploitation was sure to follow.

That stenographer, whose name was Ebenezer Howard, set about to devise a plan to achieve Bellamy's utopia, amended to include the kind of democratic governance necessary for a just world. His book, *Garden Cities of Tomorrow*, was the beginning of a movement that turned into the highly credentialed and professionalized field of urban planning that we have today. Howard's Garden City plan was meant to decentralize people, property, and power such that communities so designed would be small enough to be governed through democratic means, and provide for each person's basic needs. It was a revolutionary idea that was, like so many such ideas, never fully implemented (Details of Howard's life events from Fishman, 1982, pp. 1–33).

What follows is a kind of autopsy. Why did Howard's idea, even when partially implemented and well-funded, fall so far short of its utopian vision? Why do so many counter-hegemonic projects wither on the vine? I contend that many academics, activists, and political actors have been far too rational in their work. That is, there have been precious few interrogations of activists' role in maintaining what sociologist Max Weber called "rationalization": the funneling of all forms of knowledge and administration into quantitative measurements filtered through written rules executed by professionalized office-holders (McKinnon, 2010; Weber, Gerth, & Mills, 1958). This investigation suggests that efficiency undermined fundamental aspects of the Garden City project and has therefore, never been attempted in any substantial way.

Rationalization encompasses how individuals make sense of the world, how governments rule, and what aspects of the universe are within the realm of scientific testing and understanding. It is not likely that any single strategy can undo rationalization, and a complete up-ending of Enlightenment reason would be throwing out the baby with the bathwater. Instead, this essay proposes that those seeking to build a world outside of or beyond capitalism should pay attention to the way their projects relate to and support efficiency. Efficiency appears to be a tool that is especially bad at dismantling the master's house. In its place, I propose that those seeking to build counter power institutions and communities would benefit from learning to think in terms of recursivity.

Recursivity engenders a concern for *reproduction* rather than simple production. It recognizes that property is not only theft, but also a destructive force that is antithetical to the kind of closed circuits and self-referential loops that make for sustainable systems. Recursivity is thus a kind of metric for what Eglash (2014) calls generative justice. Generative justice, simply put, is keeping value close to its source of production and reducing the constituent

factors that lead to alienation, thereby increasing autonomy of individuals and small groups. Since the “value” that is circulated in generative justice can be both material as well as semiotic—it works whether we are sharing code or compost—we can simply say that the better a system is at utilizing its outputs as inputs, the higher its recursivity. However, “better” does not simply mean “more.” That is, recursivity may not scale the way that efficiency scales and monocultures, where a single actor’s inputs and outputs dominate the ecology, are not necessarily emblematic of recursivity.

Output/input relations at one level can be nested within meta-output/input at a higher level. For example, open source development communities that build the tools that are both the basis for and the medium through which the community members contact one-another can form a recursive public (Coleman, 2012; Kelty, 2008). Thus recursivity is ultimately reflecting the system’s ability to sustain and nurture its own generative capacity. It also follows that something that reflects or is imbued with recursivity should be organized from the bottom up, with hierarchies only going as “vertical” as self-similar features can withstand. In other words, the scaling properties of recursivity are bounded by the ability of the system to maintain self-similar organizational schemes at every level of the system’s hierarchy. Maldonado and Mezza-Garcia (2016) note that “complexity theory is teaching contemporary scientists that the best way to generate order in a complex system is by letting it self-organize in interaction with its environment” (p. 3). They go on to further note that even though problems of governance continue to exhibit increasingly more complex scenarios, “self-organization, it appears, has been traditionally avoided in the history of social human systems, and diverse mechanisms have been developed to impede it” (p. 3).

From this perspective, a social system’s ability to provide an alternative to capitalist modes of production should be assessed based on how well its human and non-human actors, interacting with(in) the system, can easily expand that system and create new capacity across multiple dimensions. Howard’s garden cities are one of many examples of projects that gesture towards recursivity but have failed, at least in part, because the metrics that would have properly described their sustainable and resilient characteristics did not exist in the imaginations of decision makers and the public.

In general, recursivity engenders the following qualities:

1. Easy to understand guiding principles that scaffold individuals’ action into predictable and socially desirable outcomes.

2. An extremely close, if not totally indistinguishable, connection between means and intended ends.
3. Sensitivity to closed loops and a seeking out of opportunities to link up, make compatible, or otherwise connect the inputs and outputs of a system.
4. Sustainable scalability that, rather than seeking control over possible externalities, seeks to make systems adaptable and flexible to unpredictable events or conditions.
5. Sharing and fecundity, rather than ownership and scarcity.
6. Mutual trust and individual autonomy, rather than competition and control.

Following Amster et al. (2009), Laura Portwood-Stacer (2013) defines praxis as “the way in which political, philosophical ideals are strategically put into activist practice to bring about material change” (p. 19). Paulo Freire (2000), in his *Pedagogy of the Oppressed* defines praxis as simply “reflection and action upon the world in order to transform it” (p. 51). Crucial to the project of recursivity in particular is Freire’s observation that, “oppressive reality absorbs those within it and thereby acts to submerge human beings’ consciousness” (p. 51). Ergo, the very project of liberation is steeped in recursive cause and effect relationships. Oppression calls up oppressive ideas within individuals in order to maintain the “contradistinction of men [sic] as oppressors and oppressed” (p. 51). Freire recognizes the recursive relationship between ideas and material reality when he writes,

the oppressed must confront reality critically, simultaneously objectifying and acting upon that reality. A mere perception of reality not followed by this critical intervention will not lead to a transformation of objective reality—precisely because it is not a true perception.

(Freire, 2000, p. 52).

Freire’s contention that the “absorption” of oppressive reality into one’s consciousness is what maintains oppression and that one’s “perception of reality” should be “followed” by intervention suggests that a fruitful site of intervention would be cultural or even epistemological in nature. Before recursivity can be put into practice then, there needs to be a collection of ideals or set of perspectives that drive action. Recursivity can be applied across many domains—technical, ecological, artistic, and so on. In some cases, it could be interpreted in a rigorous, quantitative form; in others metaphorical or philosophical. My intention here is to introduce it in the more general sense of what Linda Layne (2000) calls a

“culture fix.” Instead of placing hopes in a particular device or gadget (e.g. a technological fix), or in a change in a policy or formal institution (e.g. a social fix), the cultural fix focuses on changing the perceptions, conceptualizations and practices that directly interact with technologies.

In this case the culture in question is what Langdon Winner (1977) calls technocracy: the institutional culture of designers, planners, engineers, and anyone else involved in the kinds of projects in which efficiency is a fundamental metric within rationalized means of organization and production. Given the multi-faceted and pervasive nature of technocracy, it would be futile to put forward a single program for its undoing. Instead, I offer a sort of archipelago of related starting points for undoing the technocracy brought about through rampant rationalization. In addition to reformist, prefigurative, speculative, or even utopian design interventions, this essay suggests that activists and academics alike pay particularly close attention to the metrics by which they assess existing or possible sociotechnical systems.

I begin interrogating rationalization in general, and efficiency in particular, by retracing the critical perspective on rationalization begun by Weber, and outline the advocacy role of social scientists in promoting recursivity over efficiency. Next, I explore the mutually-shaping relationship between rational organizations and technological systems, as it pertains to the division of labor. This is crucial because if we are to understand where a project like the Garden City went wrong, we have to pay close attention to the way human relationships and built environments interact. I will then describe in some detail the concept of recursivity, how it acts, and what it might look like in implementation. Here I put forward the supposition that recursivity offers us a way out of proleterianization and a way towards a new means of common ownership. Finally, this essay will conclude by revisiting Howard’s Garden City and what went wrong. I argue that it was a focus on out-producing capitalism and insufficient guards against capital accumulation that ultimately doomed the Garden City.

2. Re-enchantment as strategy

Underlying Winner’s technocracy is the aforementioned process of rationalization. For Weber, modernizing was the systematic disenchantment of the world. Science came to replace magical or animistic explanations, bureaucracies organized by the rule of law replaced the divine rights of kings, and what one did for a living had more to do with the money it provided rather than any sort of station or caste defined by religious or otherwise internally consistent logic.

While recursivity is not a call for a return of monarchy or the four humors, it is a push against the irrationality of the rational world. “Weber always had in mind” wrote Gronow,

[rationalization’s] peculiar formal and abstract nature, which was expressed most condensely by the quantitative nature of formal rationality. Formal rationality of an economic order, while representing the peak of efficacy and calculability, was irrational in the last instance, because it rejected all genuine substantive value considerations from the sphere of economics. The most rational type of action was at the same time the most irrational one.

(Gronow, 1988, p. 325).

Recursivity then, is an opportunity to re-enchant our world with genuine, substantive value considerations from not just economics but also, ethical, moral, critical, and social thought. By paying close attention to the linking up of inputs and outputs one decreases their chances of creating an alienating organization that ignores what is commonly called “the realities on the ground.” Recursivity, in this way, might be expressed as simply as rotating management and server positions in a restaurant. By giving every server the opportunity to “view” the restaurant from the point of view of the manager, and visa-versa, all workers develop a sense of the needs of the organization as a whole. A single, dedicated manager might be the most efficient use of payroll and boss’s time, but recursivity asks that we value other things.

The example of the restaurant immediately highlights many of the challenges in implementing recursivity. An organization working on razor-thin margins cannot afford to experiment on its own. Weber even speculated that “‘alternative movements’ to formal rationality demanding the incorporation of some substantive values or principles ... are immediately faced with the ‘demands of the day’” (Gronow, 1988, p. 328). This is because, in a rationalized world, success itself is expressed in rationalized, quantified metrics such as profit. What then is the model of change in such a situation? Here it would be prudent—because this is a cultural fix—to take a cue from cultural studies scholars like Raymond Williams, who notes that hegemonic discourse can only be disrupted through the fostering of alternative and oppositional cultures. Such cultures can take on either residual or emergent properties, meaning that they can draw inspiration and source material from both the past and an imagined future (Williams, 2006).

Social scientists have many roles in society. They identify trends that might be useful to people in important decision-making roles, analyze everyday life so that we might one day improve on that life, and lend an informed and critical perspective to complex social problems. At a more theoretical level though, the social sciences are useful to the general public because they give names to previously unutterable feelings or relationships and, in so doing, produce new possibilities for solidarity and cultural practices. Sometimes the social scientist is naming an undesirable or destructive phenomenon. Much like a priest performing an exorcism (if the movies about such are to be believed), a social scientist has to “name the demon” that has taken control of the social body. It is through a name that social movements or even policy can grasp the intangible and either bring attention to it or exorcise it completely. The work of writing and building theory might also be best understood as the practice of grabbing hold of previously intangible demons and casting them out through the invocation of new names.

Such an approach also invites us to view this problem in a decidedly non-rational fashion. Weber, in his own writing, made frequent use of borrowed chemistry terms to describe social activity (McKinnon, 2010). This is curious decision given that Weber’s dedicated his career to criticizing rationalization in all of its forms, which included appeals to the natural sciences for all aspects of human life. While stopping short of calling it a “methodology” this essay does advocate a certain style that leaves room for metaphors and thought experiments that encourage a more enchanted view of the world. To re-enchant the world with recursive thought is to bring focus back to the inherent benefits of fractality, complexity, randomness, cooperation, symbiosis, and even chaos that appears in nature (for more on the natural and social interconnectedness of these phenomena see Maldonado & Mezza-Garcia, 2016), but with the understanding that all of these things have underlying knowable characteristics that can make them useful towards specific goals. Crucially though, is the acknowledgement that some relationships or phenomena are not completely understandable and can stay that way.

As we seek out and name efficiency in all of its forms (far too many to enumerate here) we see that it has penetrated nearly all ways of knowing. Efficiency is deeply embedded as an unalterable natural law; from quantitative physics (“thermal efficiency,” “electrical efficiency,” etc.) to metaphoric conceptions of individuals, social groups and even whole nations (Gowdy, 2004). Thus we almost intuitively seek it out, know when it is missing, and impose it on our

various tasks and jobs (Ellul, 1964; Mumford, 2010; Virilio, 2006). Proposing a new metric like recursivity is thus meant to act as an innovative lens with which to see the world, equally applicable across multiple ways of knowing: conceptual classification schemes, organizational tools, philosophical shorthands that identify processes, procedures, and organizational logics. All of which might promote or enable generative justice. Just as many people might readily recognize the benefits of a fuel-efficient car, a pervasive literacy in recursivity would enable similar measures, intuitions, practical judgments and aspirational visions about technologies that afford generative justice.

To give a more concrete example of all of this, consider a brief back-and-forth that occurred at the 2013 Engineering, Social Justice, and Peace conference wherein Randika Jayasinghe, an engineer from The University of Western Australia, was describing a labor-intensive recycling program that was spread across several different companies in Sri Lanka, each taking a different material, using separate trucks to take each. Another person in the room asked why there had not been any attempts to centralize the process so that it was less labor-intensive, used fewer trucks, and recycled a higher percentage of waste. Jayasinghe's answer, which focused on the fact that employment and simplicity of the recycling process were just as important as the amount of material recycled, revealed a tension between resource efficiency and social benefit (Jayasinghe, 2013). This is, in essence, what recursivity is about: supporting an ecology of mutually-reinforcing positive social outcomes even at the cost of one or several constituent factors not reaching their theoretical maximum potential.

Sometimes the new practical and material organizations that come out of theoretical interventions are reformist in nature, as when political scientists categorize various kinds of democratic theory and put them to work within institutions by describing the costs and benefits of changing tactics or internal decision-making systems. On the far opposite end of the spectrum are the revolutionary consciousness-raising projects that inspire direct action through an innovative analysis, new empirical data, or a combination of the two.

This project is closer to internal reform than foundational revolution, although, like many attempts at building counter power, it is my hope that this new project grows in the shell of the old until it ultimately replaces the ideology of efficiency. Counter power organizations are democratic systems that seek to provide the kinds of goods and services currently provided by corporate or state actors and, in so doing, weaken their popular support. Counter power is both a strategy and a theory of capitalism put forth by Pierre-Joseph Proudhon, a French political theorist and the first recorded person to call themselves an "anarchist" (Proudhon,

2011). To be clear, the model of change I am advocating is not for academics to necessarily go out and establish new restaurants, publishing houses, or energy companies on their own (although that too, would be welcome) rather the emphasis here is on articulating and promoting a set of ideals upon which new organizations can be founded. Additionally, it is important to make distinction between capitalism as a process of wealth accumulation and privatization and market mechanisms which, when properly bounded and tied to social needs and desires, can be a useful means of resource allocation.

As activists, entrepreneurs, and academics set out to establish new organizations built with recursivity in mind, they will provide grist for the analytic mill. More specific tactics, strategies, or (eventually) analyses of successes and failures may be best found in cultural studies. There are, however, many beachheads to this fight but arguably one of the largest is economics. It is in this discipline that efficiency as a value, morphs into a seemingly observable natural phenomenon. Economist Daniel W. Bromley (1990) put his finger on this precise process when he wrote: “‘economic efficiency’ has no logical claim to ‘objectivity.’ And, if efficiency has no secure claim to objectivity, then its recommendatory value for determining ‘goodness’ is immediately undermined; it survives as a mere value judgment of the economist who recommends it” (p. 87).

According to Bromley, efficiency emerged as both an objective property of social action and a desirable outcome of economic policy during the interwar years, as Western governments were just beginning to adopt popular welfare policies to alleviate poverty. For the first time, governments approached policy as a calculus of benefits compared to expected costs. John Hicks and Nicholas Kaldor, two very influential economists at the time, proposed that economists (and thus government policy that relied on their recommendations) deal solely with the production of goods and leave distribution up to private interests and bureaucrats. “Economics” writes Bromley, “came to be about the production of commodities and the ‘utility’ those commodities could impart in consumption” (p. 91). Hicks and Kaldor argued that how people used these goods to increase their welfare should be left up to political scientists and sociologists. This division of academic jurisdiction—in conjunction with the myth of a self-regulating market—meant that hot-button issues like income distribution were a matter of policy instead of economic analysis (Bromley, 1990; Gowdy, 2004).

The consequences of this obscure and academic distinction have been immense. The boundaries between what is considered “natural” market forces and government intervention are the upshot of economists’ consensus that one can only objectively observe production, consumption, and allocation. Human welfare, the nature of work (outside of how quickly or

cheaply it can be accomplished), and (most importantly for the project of generative justice) the degree to which value is returned to its human producer have been forgotten by the fundamental measure of productivity.

For those interested in building counter power organizations, there are all sorts of informal assumptions and formal policies that threaten to diminish their democratizing effects. Moving from top-down authority to bottom-up recursivity makes organizations unrecognizable to regulations and practices that expect hierarchical order and designated officials that can speak for the group. Even small deviations from the norm, like employee ownership of a company, can reveal widespread obduracy that stretches from regulatory bodies to clients' prejudices. For example, New York City gives preferential status to minority-owned businesses when selecting contractors. This important redistributive measure is, however, unable to accept applications from employee-owned businesses even if those businesses are comprised entirely of minorities (Jaffe, 2015). Employee ownership is (as the brief restaurant example above demonstrated) a straight-forward implementation of recursivity that is relatively common in the American context (Alperovitz, 2013) and yet it frequently meets similar regulatory hurdles.

So far I have focused on the ways present organizational formations impede the adoption of recursivity and what social scientists might do to promote new forms of organization. This is only half the story because, as Winner and Ellul have argued, our technologies are the ultimate instantiation of Weber's rationalized society. What follows now is a deeper dive into how organizations shape our technologies and what the implications are for the division of labor.

3. Technological Systems Under Capitalism

If activists are to shift from a praxis that measures process according to efficiencies, to one that focuses on recursivity will require significant changes in both the practice and products of our technological society. Such a direct affront to something as fundamental as efficiency will no doubt raise suspicions that this is an argument for Luddism (as it is popularly understood; as something "against" technology) or some other romanticized call for eliminating machines in one's day-to-day life. Nothing, in fact, could be further from the truth. A recursive perspective requires us to acknowledge that humans and technology have been co-evolving throughout their existence. We were always already cyborgs. The only question is which of

many possible pathways this symbiosis should take. The famed philosopher of technology Lewis Mumford notes that we reached a critical crossroads when the industrial revolution allowed machines to achieve a kind of physical self-reference: “One of the first products of the machine was the machine itself” (Mumford, 2010, p. 334).

What follows then is a short but representative sample of different accounts of the mutually shaping relationships of machines and culture starting with the observations of medieval Europe made by Lewis Mumford and ending with the cross-cultural, reflective practices that have come to dominate more contemporary design and science and technology studies literatures. I will be giving explicit attention to the ways in which engineering is both a “war-built” (Nieusma & Blue, 2012) discipline and an isometric (Hughes, 2012) physical instantiation of capitalist command-control structures. That is, this section will produce a rough genealogy of efficiency (prior to its most explicit instantiation in economics) such that recursivity can be explored as its foil.

The interdisciplinary field of Science and Technology Studies (STS) has long been interested in the mutually shaping relationships of large technical systems and social organizations and bureaucracies. One school of thought, Social Construction of Technology (SCoT), dominated much of STS critique of this topic beginning in the late 70s through to the early 90s and remains a touchstone for this line of inquiry. Theorists in the SCoT tradition sought to show that technology did not follow a linear progression of innovation and development based solely on rational calculation and testing, but was instead a deeply social process that was contingent on historical events and group dynamics as well. Everything from inter-continental missile accuracy (MacKenzie, 2012) to the manufacturing process for fluorescent lighting (Bijker, 1992) in their present form could have been otherwise.

This does not mean, however, that systems are totally unpredictable in their creation and development. SCoT can help us outline exactly how capitalist value systems frame and structure the process of invention and the subsequent evolution of technological systems. Foundational SCoT theorist and historian Thomas P. Hughes (2012) observed that at their most basic, technological systems are physical artifacts, organizations, scientific artifacts, legislative artifacts, and natural resources that “solve problems or fulfill goals using whatever means are available and appropriate; the problems have to do mostly with reordering the physical world in ways considered useful or desirable, at least by those designing or employing a technological system” (p. 47). These systems “manage increasingly to incorporate environment into the system, thereby eliminating sources of uncertainty,” (p. 47).

Hughes also identified six discrete phases of evolution that technical systems go through. These are invention, development, innovation, transfer and growth, competition, and consolidation. These phases tend to "overlap and backtrack" throughout the life of the invention, as usage patterns change, styles evolve, and new technologies come to market. These phases are in a capitalist context in Hughes' examples; they have somewhat different characteristics in the socialist context of, say, the USSR during the same time period. Yet the outcomes are quite similar: few technologies help return value to the human labor or ecological features that generated it.

Radically new inventions like the light bulb or steam engine begin life as unrecognizable proofs-of-concept that have to be developed into products; either winning state loyalty in socialism or market loyalty in capitalism. After this stage, at least according to Hughes's account of the capitalist system, the initial inventor is rarely in control of the direction of innovation. New players refine and develop the invention, transferring the technology and growing its influence to new sectors of the market economy. Competitors for the same kind of product develop but as more and more people rely on the invention for day-to-day activity, the invention consolidates into a recognizably standard form. For example, railroad companies had to standardize the width between rails and share precise timetables to provide reliable services that benefited from cost-saving economies of scale (Gordon, 1996).

Under capitalism, firms that control large technical systems seek out efficiencies while also establishing stability. Inventors and entrepreneurs, according to Hughes, hedge their bets against uncertain conditions beyond their system's reach by diversifying the components of the system (e.g. an energy company that has large holdings in coal as well as wind power), creating redundancies (e.g. parallel backup servers that host social media services), and building the capacity to weather "peak loads." A peak load is a short burst of increased network activity—mobile phone usage during a disaster or electricity during a heat wave—that if unaccounted for can cause a network to fail.

As I will demonstrate below, the tendency to eliminate uncertainty by diversifying markets, accounting for peak loads, and expanding controllable variables are necessary measures in a competitive market economy where efficiency is the metric for success. The efficiency-seeking behavior of firms and their isometric technical systems do an excellent job of accumulating capital into hierarchical organizations, but they do little to promote generative justice. They seek to reduce the number of people making meaningful decisions in favor of predictable command-and-control hierarchies.

Hughes' theory of the evolution of technological systems explains why for-profit firms are focused on efficiency, but it does not explain why dual power organizations or anyone not interested primarily in efficiency would be affected by these firms' behavior. How does efficiency influence those that might otherwise be dedicated to generative justice and the qualities of recursivity? The most-straightforward reason is that dual power organizations almost always have to interact with large technical systems for one reason or another, whether it be as business partners, political adversaries, or simply rival buyers of the same good (Graeber, 2009; Harvey, 2012).

There is also a much more subtle and pervasive way that large technical systems impose an ethic of efficiency on those otherwise inclined to work towards recursivity. The products or services produced by firms reproduce and reify the social relations that produced them. In other words, as Lewis Mumford (2010) once observed "we cannot intelligently accept the practical benefits of the machine without accepting its moral imperatives and aesthetic forms" (p. 355).

Mumford was deeply skeptical of technologists' claims about machines' time saving properties. He noted that while steam and electric-powered devices sometimes saved effort or time, "an elaborate mechanical organization is often a temporary and expensive substitute for an effective social organization or for a sound biological adaptation" (2010, p. 275). Technologies, especially when many people rely on them, tend to change social habits rather than simply augment or mediate them. Mumford is careful to note that mechanical devices do not impose their own kind of politics, rather politics works through technologies to order human life.

Nowhere is this seen more acutely, according to Mumford, than life under the precisely measured time brought about by continental railroads: "Under capitalism time-keeping is not merely a means of coordinating and inter-relating complicated functions: it is also like money an independent commodity with a value of its own. The school teacher, the lawyer, even the doctor ... conform their functions to a time-table almost as rigorous as that of the locomotive engineer" (2010, p. 270). Technologies like time-tables and the trains that rely on them make it possible and even necessary, to control people at never-before-seen scales and magnitudes.

Jacques Ellul (1964) also recognized that machines were not the sources of what he called "technique" so much as the methods by which it was enacted. He defined technique as "the totality of methods rationally arrived at and having absolute efficiency (for a given stage of development) in every field of human activity" (p. xv). Technique, according to Ellul,

predates and is the motivation for the invention of both the machine and capitalist modes of production.

While Mumford and Ellul contend that there is some kind of ideology of efficiency that acts as a necessary pre-condition for the invention and development of the machine and the economic conditions it works under, Harry Braverman (1998) sees capitalism as the driving force of mechanization. According to Braverman it is machines that make it possible to maintain “true control over a highly productive factory by a relatively small corps of workers” (p. 159). What capitalism identifies as progress is always something that further subordinates workers to machines, either through increasing the complexity of the machinery such that only specialists can understand how it works or by mechanizing a process such that individual workers do not know how to do their job without expensive machinery.

What I have described thus far are instances where power is concentrated at the top through a process of mechanization. There are also instances where technology is launched first in order to create the exploitative organizational scheme. High Yield Variety (HYV) rice is a genetically modified strain that grows too thick and heavy for hand-held harvesting equipment, and requires artificial fertilizers and pesticides to keep alive. HYV delivers on its name, but it would be equally accurate to call it “high overhead variety” rice as well. The necessary equipment is expensive and difficult to use and often ensnares entire communities in exploitative credit and debt systems (Eglash, 2006; International Rice Research Institute, 2007; Peletz, 1988).

Layosa (2007) describes the introduction of HYV rice in the Philippines as a means of consolidating power in a political struggle. While HYV rice provided a temporary increase in food production it created a permanent system of control over communities of rice farmers that participated in popular political demonstrations against the American-backed government. After a crackdown on civil liberties and several orchestrated rice shortages, the government instituted farming reform, “imposed in the form of credit packages of fertilizers, pesticides, irrigation and machinery” (p. 19).

It is worth stating at this point that neoliberal state actors are not the only regimes that have exploited millions in the name of production quotas. Communist vanguard revolutions have also been adherents to the gospel of efficiency. Paul Virilio (2006), in his *Speed and Politics*, asserted that states’ ability to transcend time and space through the speed of technology was the driving force of states regardless of ideology. He contended that it was the communist revolutionaries of the twentieth century that dressed themselves in military

paraphernalia that were the “ultimate capitalizers on the productive act ... It’s from them, and not from vague philosophers or ideologues, that the political idea of *nations on the move* was born” (p. 57).

Vladimir Lenin was particularly fond of scientific management (often described as “Taylorism”), which he saw as a powerful tool for accelerating production and even instilling the new socialist culture in the peasant class. “The Taylor system,” wrote Lenin “is preparing the time when the proletariat will take over all social production and appoint its workers’ committees for the purpose of properly distributing and rationalizing all social labour” (Quote from V.I. Lenin’s “The Taylor System—Man’s Enslavement by the Machine” as quoted in Sochor, 1981, p. 248). The only politically tenable position for fellow revolutionaries were varying degrees of interpretation and implementation of rationalized and highly efficient forms of work and even culture (Sochor, 1981).

The neoliberal turn of the twenty first century has given rise to dramatically more pernicious forms of control that were unachievable by state-sponsored communism or industrial capitalism alone. Just as Ellul and Braverman agree that there was a causal relationship between machines and capitalism (although they disagree in terms of which prefigured the other), so too is there a co-constituting relationship between digital networks and neoliberal forms of control. Digital machines retain the benefits of efficiency, but are also able to work in decentralized networks that appear to be democratizing.

Alexander Galloway (2006) warns these kinds of big data systems herald a new form of control that does not require the direct hierarchy or control systems that concern Hughes and Mumford. He contends that protocols, “the technology of organization and control operating in distributed networks,” (p. 317) are actually far more robust and at times insidious forms of control. For Galloway, distributed and decentralized networks are not the inherently democratic or anti-authoritarian structures that Marxist critics Deluze and Guatarri claimed they could be (Galloway, 2001, 2006, 2011). Protocols “structure relationships” and regulate flows amongst and between bits and atoms, such that control is harder to detect and might even appear to an individual as their own free choice rather than a calculated directive.

Galloway, however, provides no examples of where and how protocols actually configure human relationships. He insists that the Internet and the American interstate highway system are examples of protocol at work, but he never fully articulates how, at the level of protocol (i.e. the code that routes Internet or highway traffic), control is exerted on unwilling or external actors. That is, with the exception of Zimmerman (2011) and Torsen (2008) who make the case that western dominance in the tech industry has been an obstacle for coders

that do not use roman character sets, it is difficult to find the clear-cut cases of exploitation that Galloway describes. The examples by Zimmerman and Torsen, rather than bolster Galloway's claims, seem to instead support the observations by Gray and Gordo (2014) who argue that globe-spanning digital networks are better described as a, "metahierarchy" of multiple, smaller hierarchical nodes that aggregate into a mesh (p. 258). A metahierarchy that contains many hierarchies that employ roman character sets would have a strong influence on the overall mesh, but such influences are vulnerable to "pushing back" or being "diluted" by an increasing number of new hierarchies using different character sets.

It may be that digital technologies represent a change in degree, not kind, of control. Franco "Bifo" Berardi (2011) contends that digital technology "takes to the extreme the tendency, which Marx analyzed, for labor to become abstracted from concrete activity" (p. 89). Computer networks recombine and recompose old forms of exploitation in a way that far out-paces labor's effort to organize itself. That is, information technology has not really produced unseen kinds of precarious work, rather it has *reintroduced* the kinds of precarity that organized labor largely eliminated in a few countries during the middle of the twentieth century. For Berardi, digital technologies are simply extending the efficiencies of capitalism into cognitive work that was previously difficult or impossible to rationalize and turn into efficiently produced commodities.

The sociologist Zeynep Tufekci (2014) strikes a middle ground between Galloway and Berardi in what she calls *computational politics*. "*Computational politics*" Tufekci writes, "refers [to] applying computational methods to large datasets derived from online and off-line data sources for conducting outreach, persuasion and mobilization in the service of electing, furthering or opposing a candidate, a policy or legislation" (para. 4) It enables powerful actors to craft tailor-made messages that seemingly speak directly to the issues and concerns of individuals, while obscuring the whole picture. Tufekci is more concerned about the institutions and practices that make up civil society, than about modes of production, but the commodification of personal data blurs that distinction to the point of irrelevancy.

Amidst these strange and subtle forms of control, there are also new forms of democratic decision-making. One example that is of obvious interest to the articulation of recursivity is Chris Kelty's "recursive public." The recursive public is a public that is concerned with and thereby comes together over the "material and practical maintenance and modification of the technical, legal, practical, and conceptual means" (2008, p. 3) of its own continued existence.

Kelty is very restrictive when it comes to labeling something a “recursive public.” Any group that does not keep the fruits of its labor in the public domain cannot, according to Kelty, be considered a recursive public (Kelty, 2008). Eglash and Banks (2014) seeking to turn a single point into a spectrum, have coined the term “recursive depth” to describe sociotechnical arrangements with varying degrees of positive feedback loops. Some groups or organizations (e.g. Wikipedia) do not meet all of Kelty’s requirements for a recursive public but still, have recursive elements worthy of theorizing. They describe three dimensions on which publics become recursive: public/proprietary systems, transformations across online and offline states, and transformations along a social power spectrum.

Eglash and Banks (2014) note that, “what is perhaps most striking about open source is its ability to build ‘upon itself’ into a semiautonomous alternative arrangement: one with a synthesis of legal, technical, and social attributes that can flourish even when interacting with more dominant competing forms” (p. 109). They go on to describe how the open source operating Ubuntu Linux “must strive to keep its code open. But as a company ... must find ways to give users access to popular services that run counter to its stated philosophy” (p. 109).

It is in this dynamic that recursivity aims to intervene. By articulating what is good and useful in relationships that value affordances for reciprocity over favorable ratios of inputs to outputs, recursivity can help organizations better articulate the border between themselves and the “more dominant competing forms.”

4. Recursivity as an anti-authoritarian metric

Recursion is a big part of recursivity but it is not the whole story. Recursion refers to a system in which outputs at one iteration become inputs to the next. Feedback loops, such as a thermostat regulating temperature in an hour, would be one example. Recursion can also be visualized: self-similar repeating elements that can be seen when holding a mirror up to another mirror, Russian nesting dolls, the chambers of a nautilus’ shell, and fractal designs like the *Sierpinski triangle* are all examples of recursion. Recursion is used in a more specific way in computer science, as when a function calls upon itself in order to solve a larger, more complex problem (Hofstadter 1999).

Recursion is a powerful concept that has a very specific definition in mathematics and computer science. I have chosen to coin the neologism “recursivity” for two reasons. First, I do not want to instigate debates about whether or not something is “truly” recursive in the

mathematical sense. Recursion is a conceptual basis for recursivity in the same way that “equality” is a conceptual basis for democracy; one need not ask how mathematicians define equality to use it. I want to make a clear distinction between the mathematical source material I am drawing from, and the kind of social relations that recursivity promotes. Recursivity is a social condition, not the dutiful execution of a mathematical property. In the same way, a worker that has been scientifically and minutely exploited through computer-aided Taylorism embodies an idea of efficiency, but this is still a far cry from the abstraction of efficiency in physics which might require a frictionless environment, bodies with infinite hardness or other precise idealizations.

The systems that exhibit the most recursivity are those that contain within them all of the parts and practices for their maturation and expansion. Recursively deep systems are also sustainable in a very fundamental way because the means by which they are sustained are also deeply intertwined with their political, cultural, ecological, and social ends. Lenin was able to adopt Taylorism (Sochor 1981) because ends and means were completely separated under his communism. Unlike the linearity of the efficient factory that transforms resources into goods, recursive formations seek out loops that connect inputs to outputs.

Perhaps the best way to illustrate the relationship between—and thus the character of—both the *status quo* of efficiency and the insurgent counter power of recursivity is to investigate a historical moment wherein recursive organizational forms existed side-by-side with more efficient ones, but the former were dismantled to make way for more of the latter. History has many such unfortunate stories, but one that has been retold time and again as a kind of urban legend¹ that lends legitimacy to capitalistic property ownership and eschews collective self-organization as always already doomed to failure is the so-called “Tragedy of the Commons.” By revisiting this history I aim to give a fuller picture of what recursivity speaks to and what it will hopefully displace.

It is not uncommon to hear the phrase “Tragedy of the Commons” when talking about access to what economists tellingly call “rival goods.” That is, goods that are used up such that

¹ Woolgar and Cooper (1999, p. 440) note that the academic “urban legend” “possess a four-fold structure which organizes the telling of the tale” consisting of boundary violation, contamination or embarrassment which is contingent on the boundary violation, delayed realization of the contamination or embarrassment, and finally “self-replication (further spread/contamination) can occur before the condition is detected.” Woolgar and Cooper were making the point that while there were major factual inaccuracies in Winner’s often-cited “Do Artifacts Have Politics?” (1980), the structure of the story actually preserves the analytical point he was making. Hardin was also factually wrong but his theory, for better or worse, still has many adherents.

one's enjoyment of them precludes other's enjoyment. "The store ran out of those" reminds us of that some rival goods are privately owned. But other rival goods are public: water, arable land, and radio bandwidth are all examples of public rival goods. Tragedy of the Commons is invoked as a justification for transferring public rival goods into the private domain. Without private ownership, the myth goes, society would fall into a Hobbesian Mad Max style fight over resources that would ultimately leave those resources ravaged and unusable for future generations.

The origin of this urban legend (like so many others) can be found in the journal of *Science*. In 1968 the economist Garrett Hardin published an article titled "Tragedy of the Commons" in which he gives a historical account of the English enclosure laws that "saved" the land and natural resources that made up the English Commons, which he characterizes as completely unregulated land. The paper uses this caricature of the commons as a thought experiment demonstrating how goods held in common will always be exploited. Without the allocation efficiencies afforded by private property, Hardin and his disciples have argued, the spoils of industrial society would be impossible to produce. Furthermore, any gains in quality of life will come from privatizing more resources.

There were contemporary refutations of Hardin's work but Susan Jane Buck Cox's article-length debunking of the Tragedy of the Commons, published in *Environmental Ethics* is one of the most thorough. Cox's "No Tragedy of the Commons" (1985) uses historical document analysis to show, not only that Hardin's characterization of the commons was factually wrong, but that in fact the end of the commons was in large part due to illegal seizures of land by wealthy landowners. Cox asserts:

The commons were carefully and painstakingly regulated, and those instances in which the common deteriorated were most often due to lawbreaking and to oppression of the poorer tenant rather than to egoistic abuse of a common resource. (1985, p. 56)

The Enclosure Acts Hardin cited as the saving grace of the English countryside were in actuality a *post hoc* legalization of something that aristocrats had been doing illegally, and with increasing frequency, for several decades. The real tragedy of the commons is that rich people will always try to take common property away and extract rents from whatever is left.

The Enclosure Acts were more than an enshrinement of individuals' greed, it was also part of a larger effort to create a market for finished goods. Rather than subsistence farming that utilized a regulated and peer-supervised commons, the rural peasantry was expected to

purchase a larger portion of their daily needs in a marketplace. Here, I argue, is where the myth of efficiency won out over the reality of recursivity. Instead of developing and improving the ability of people to access common property, capitalists restricted access to the basics of life and turned them into goods to be sold.

Recursivity requires that we develop alternative systems that stretch from raw materials to finished product. Without such a deep dive through supply chains, there is less opportunity to create the self-referencing loops that return outputs—either “waste” as in composting or “products” as in open source code—back to the system. But even that vocabulary is conditioned by efficiency: are “raw” materials ever truly “raw”? Doesn’t that already imply the “terra nullis” (1537) in which Pope Paul III decreed non-Christian lands open for ownership? Doesn’t the waste/product dichotomy erase the existence of prior generation and circulation by humans and non-humans? Recursivity measures things based on how well values are effectively circulated from the bottom-up, not how effectively they are turned into goods with attached prices from the top-down. Recursivity demands that we build new vocabulary, conceptions and process: a new commons.

It should be stated explicitly that building a new commons is not a *return* to the commons. Recursivity does not require that we become sharecroppers or goat herders, although it would be nice if that were an option left open to more people. What I am suggesting is much more incremental than any kind of back to the land movement. Instead, I am trying to nurture a reversal of proletarianization by developing a popular metric by which we can measure that reversal.

What, precisely, does private property have to do with efficiency, and how is the private property of today maintaining non-recursive systems? After all, state communism also ran efficient and unjust factories. For an answer to this question I turn to Marx’s contemporary critic Joseph Proudhon who famously decreed that “property is theft!” The full quote goes:

If I were asked to answer the following question: *What is slavery?* and I should answer in one word, *It is murder!*, my meaning would be understood at once. No extended argument would be required to show that the power to remove a man’s [sic] mind, will, and personality, is the power of life and death, and that it makes a man a slave. It is murder. Why, then, to this other question: *What is property?* may I not likewise answer, *It is robbery!*,

without the certainty of being misunderstood; the second proposition being no other than a transformation of the first?

(Emphasis in cited edition Proudhon, 2011, p. 87)

Proudhon's comparison of human slavery to material thievery is an apt one, albeit in structure not in moral equivalency. Proudhon goes on to argue that just as it is immoral to take away the freedoms of people, so too is it immoral to claim exclusive rights to an expanded vision for public goods—to land and products that go beyond the wealth accumulated through labor.

More recent studies into modern consumerism suggests that (as the eponymous eating metaphor implies) destruction, not thievery, is more accurate in describing our relationship to property. David Graeber writes:

From an analytical perspective, of course, property is simply a social relation: an arrangement between persons and collectivities concerning the disposition of valuable goods. Private property is one particular that entails one individual's right to exclude all others—"all the world"—from access to a certain house or shirt or piece of land, and so on. A relation so broad is difficult to imagine, however, so people tend to treat it as if it were a relation between a person and an object

(Graeber, 2011, p. 499).

He goes on to observe that this creates a kind of paradox akin to Hegel's master/slave dialectic. Hegel concluded that proving one's personal sovereignty required the acknowledgement of that fact by another free person. But one cannot prove that they are truly free unless they are willing to fight to the death to preserve their present state of freedom. For Hegel this meant that in absence of any external history or social order, these two people must fight to the death to prove their freedom. But if one were to kill the other, there would be no one to acknowledge the other's freedom. One could enslave the other, but that would be meaningless because, as Graeber (2011) explains, "once one reduces the Other to slavery, one becomes dependent on one's slave for one's very material survival while the slave at least produces his own life and is in fact able to realize himself to some degree through his work" (p. 494).

Proving one's sovereignty over physical property is similarly paradoxical. One can only truly prove complete mastery over an object by destroying it. The eating metaphor, Graeber concludes, is

the perfect resolution of this paradox —or, at least, about as perfect a resolution as one is ever going to get. When you eat something, you do indeed destroy it (as an autonomous entity), but at the same time, it remains "included in" you in the most material of senses. Eating food, then, became the perfect idiom for talking about desire and gratification in a world in which everything, all human relations, were being reimagined as questions of property.

(Graeber, 2011, p. 499).

Note that the particular capitalist formation of individual property ownership is not necessarily required here; only that a single entity claims exclusive ownership, and so state-owned factories still fall into this consumer paradigm. Both state communism and capitalism eschewed the reproductive, communal sharing of the commons, in favor of the inherently destructive property regimes of states that are concerned with the efficient production of goods.

5. The autopsy: a reason that garden cities failed

So far I have described how technological systems and the socio-economic order co-constitute one-another. I have also defined recursivity as social conditions that contain within them all of the parts and practices for their maturation and expansion, and shown how organizations that demonstrate recursivity, like the commons, have historically been marginalized or destroyed all together. I have also shown how the ownership of property is inherently antithetical to the closed loops of recursivity. What follows now is a reassessment of Howard's Garden City as an example of generative justice *par excellence* and some suggestions for further research and praxis around recursivity.

Any architect or urban planner hoping to learn something about the form of a well-built city by reading the original Howard text is bound to be disappointed. Much of the book is actually devoted to the economics of purchasing land and organizing labor. It describes, in detail, the sorts of administrative bodies and tax structures that could pay off the entire estate in a fair and reasonable manner while also providing a material abundance for its residents. The form of the city was meant to follow this social function.

"Howard could argue," writes Hall (2000) "that his was a third-socio-economic system, superior both to Victorian capitalism and to bureaucratic centralized socialism. Its keynote

would be local management and self-government” (p. 95). The Garden City demonstrates all qualities of recursivity in clear contrast to competition or bureaucratization. The Garden City has never succeeded because, in fact, it has never been attempted. While the Garden City Howard sketched out in his book never materialized, it should be said that a bit of that plan can be found in almost every city touched by professionalized city planning which is nothing short of spectacular. However, the minor reforms that have their foundation in Howard’s ideas have only tried to imitate the shape of the Garden City with a few minor gestures toward the social program it was supposed to bring about. The default to the technocratic in contemporary society (Winner, 1977) suggests that mistaking a process prescription for a blueprint of a particular form will be one of the biggest challenges for generative justice project in general, and recursivity in particular. Just as the recycling center mentioned earlier was immediately evaluated based on throughput, not the maintenance of a cohesive whole, so too were the New Towns based on Howard’s vision subjected to criticisms from the political left and right that they were not fiscally responsible nor capable of housing enough poor people (Ward, 2011). Indeed while these may be defensible arguments, neither making New Towns cheaper to run or larger, would bring them closer to delivering on all of Howard’s promises. The key is to never separate the two and recognize that, as the name implies, recursivity should always have the ends embedded in the means.

This ignorance of social organization is what Colin Ward (2011) has called “the missing half of Ebenezer Howard’s formula” (p. 72). While the new towns built in the UK throughout the 1970s provided relief for the working classes in the form of substantially better housing, it fell far short of Howard’s larger social program to not only establish a society of cooperative commonwealths, but to strike a deathblow to the landowner class through financial boycott. As workers and artisans divested themselves of the city to move to Garden Cities, so thought Howard, the lords that owned the city’s land would go bankrupt.

Perhaps it was partially Howard’s fault for insisting that he was the “inventor” of the Garden City, not its planner or its discoverer (Fishman, 1982). Or maybe, as urban historian Peter Hall has contemplated, the decision to change the title to the well-known *Garden Cities of Tomorrow* from the original to: *A Peaceful Path to Real Reform*, hid the fact that Howard was outlining a social movement, not an urban development plan. In either case, too many people mistook an organizational design for a technical specification. Howard was an inventor of the Garden City in the same way that Frederick Taylor invented Scientific Management. They were actually two very similar contributions but while Taylor’s system was immediately recognized for what it was—a process of highly efficient value extraction— Howard’s Garden

City was mistaken for a blueprint rather than a method. As Hall (2002) puts it, through the years people have misread Howard and “see him as a physical planner, ignoring the fact that his garden cities were merely the vehicles for a progressive reconstruction of capitalist society into an infinity of cooperative commonwealths” (p. 88).

None of which is to say that Howard did not attempt to actually make the Garden City. He in fact came very close to making his dream a reality. At the turn of the twentieth century Howard had successfully wooed some of the wealthiest industrialists including candy maker Cadbury and Lever soap to finance the selection and subsequent purchase of a sizeable chunk of land in Letchworth. The project had received excellent publicity and all was set for construction until the wealthy industrialists did what George Bernard Shaw, one of Howard’s most vocal supporters, said would happen: they got cold feet when it came time to pay the dividends on the rents collected from the land. As Shaw surmised, none of the financiers had incentive to slowly turn the profits of land ownership over to the residents when they could simply continue to own everything and collect rent in perpetuity (Hall, 2002).

Eventually the Garden City of Letchworth became known as a well-designed, but otherwise indistinguishable small English town. Potential purchasers favored the far more common fixed 99-year lease offered to them, instead of mortgages that were supposed to be paid down over time with slowly increasing payments meant to pay for collective social services. Howard himself was quickly pushed out of any managerial role as were the like-minded architects Barry Parker and Raymond Unwin.

One reading of this process is something like a replaying of the enclosure acts. Why would owners of land in any century feel content to give up a portion of what they see as rightfully their profit from rent? There were significant incentives to turn over estate land to new working-class towns (Banks 2015), but this was done to quell the possibility of a full-scale worker’s revolt, not to decentralize the means of production. Indeed it might be those same network effects that do more to encourage centralization than induce decentralization.

We find ourselves in a chicken-and-egg situation when it comes to a problem like the Garden City. Do we need, as Howard would argue, the physical infrastructure of counter power before the social and economic ideas can mount a challenge to hegemony, or do the ideas need to proliferate so that the physical artifice can come into existence? The answer, which is frequently the case when based in Science and Technology Studies (STS) literature, is that both are inextricably intertwined and both must be accomplished simultaneously if lasting change is to take place.

There is plenty of good research in the field of STS that shows the myriad ways capitalism's insistence on imposing factory-like efficiencies impact knowledge production and circulation. For example, Daniel Kleinman (1998) has shown that the standardization of lab equipment and commercially available chemicals (in Kleinman's case a pesticide) can have a direct effect on the direction of research and the definition of a successful experiment. Andrew Pickering (1995) tells a similar story of an early particle physicist who had the dual motivations of discovering new particles, but in a manner that would preserve his preferred small-scale work environment and replace the factory-model "big science" that the Manhattan Project heralded.

The efficiencies sought by profit-maximizing organizations run very deep in the structure of knowledge-making, and so a recursive counterpoint would require a thorough revisiting of some of the basic practices of scientific inquiry and technological development. Not only would the subjects and objects of inquiry need to be critically evaluated (i.e. who benefits from what research trajectories), but the very underlying precepts of what constitutes useful knowledge and technological development would have to change. A more prescriptive STS that seeks to implement the critiques it levies would lead by example, and advocate for the inclusion of reflexivity (Gray, 2004; Sismondo, 2005) into standard scientific practice. This would require, among other projects, building new practices to replace the intricate relationships between basic research and development, and the logistical work that goes into bringing a commodity to market. Future research questions in this area would have to be nothing less than: How can new scientific breakthroughs and technological developments be distributed to populations using a commons-based approach in the place of a traditional marked-based commodity profit scheme? The biggest breakthroughs though, will require methodologies and tools unimaginable today.

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