Complex Systems and Social Change

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1. Introduction

The climate is a complex dynamic system. The system allows for considerable variability across years, but it was relatively stable for some time, meaning that the average weather over centuries remained within an expected range. This, in itself, is remarkable, given that the climate is influenced by so many factors, including the water cycle, the carbon cycle, shifting conditions at the core of the earth (did you know there is a "rock cycle"?!), biochemical cycles, and of course human activity.[1] This stability occurs because there are feedback loops between the cycles at different levels that adjust for variation. Complex systems need not be as large or as complicated as climate, e.g., something as simple as body temperature involves looping interaction between systems (the nervous system, circulatory system and limbic system).

As we all know, the climate is changing more dramatically, and variation is no longer within the normal range. I raise the fact that the climate is a complex dynamic system because we have become familiar with the idea that the climate is not like a car engine that is easily decomposable into mechanically interacting parts. We know that climate involves complex interactions between different subsystems, and that there are risks of reaching a tipping point where changes may rapidly cascade. However, another lesson we learn from discussion of climate change is that although humans are not in charge, we can make a difference. Particular individuals and institutions can have significant influence, and we must engage in collective action to change our relationship to and exploitation of the environment.

If we begin to see society as a kind of complex dynamic system, then, I hope, we can better understand its stability, its variations, and its potential for transformative change. Like climate, societies also have a variety of interacting subsystems (the economy, the political system, religions and other cultural formations), also material subsystems (transportation systems, health care systems, carceral systems). A fundamental assumption of social theory is that social formations are at least partly composed of individuals and individual agency is important in explaining how they work. That gives us the *macro level* (the system) and the *micro level* (the individual). But, I maintain, there is a *meso level* that is not always aptly recognized: the level of social practices. Social practices are a site where culture is enacted by individuals in response to material conditions, and relationships and networks are formed.[2] These networks are the structures of social systems.

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[1] "None of the systems within the biosphere (living systems), geosphere (solid parts of the Earth, including the lithosphere or uppermost layers), hydrosphere (mass of water found anywhere on Earth), and atmosphere (layer of gases surrounding the planet) operate independently of the others." https://www.bioedonline.org/online-courses/educator-certification/generalist-4-8/cycles-in-earth-systems/

[2] Tilly: "In relational analysis, logical and ontological micro-macro problems dwindle to insignificance … because relational realism concentrates on connections that concatenate, aggregate and disaggregate readily, form organizational structures at the same time as they shape individual behavior. Relational analysts follow flows of communication, patron-client chains, employment networks, conversational connections, and power relations from the small scale to the large and back." (1996/2002, 41) See also Kim 2024.

Social phenomena occur at different "levels" (micro, meso, macro), and systems can be studied at different degrees of generality. For example, at the macro level, if we are interested in capitalism, as a system, one set of questions concerns what is essential to capitalism, or what possible social formations count as capitalist. Another set concerns the historically specific form of capitalism that has evolved and is actually entrenched now (Arruzza 2015a, 2015b; cf. Berman 2022, 132). The same contrast may be made for patriarchy or White supremacy. The two sets of questions (level and generality) may yield different conclusions. Our actual social formation – the historical token – may be a fusion of capitalism, patriarchy, and White supremacy, but the fusion may not have been necessary, even if it there is a "structural basis for the entanglement" (Fraser 2022, 40).

I favor a single complex system approach to our historically specific social formation. But we cannot understand this social formation without identifying the co-integrated subsystems that make it up. On my view, the relevant sub-systems are *not* patriarchy, White supremacy, and capitalism; instead, the sub-systems include health care systems, education systems, and the like. They are patriarch*al* or White supremac*ist* insofar as the dynamics of the system produce and reinforce gender and/or race oppression. To understand the issues, it will be helpful to say more about systems theory, and to sketch my own approach to social systems.

2. Social Ontology

Here is a rough sketch of the social ontology I have defended:

Practices: Social practices regularize our behavior in response to each other and the world so that we can effectively communicate and coordinate. Practices, as I understand them, are patterns of learned behavior, but need not be guided by rules or performed intentionally, and they allow for improvisation. However, they are not mere regularities in behavior, either, for they are the product of social learning and evolve through responsiveness both to each other's performances and the parts of the world we have an interest in collectively managing. In short,

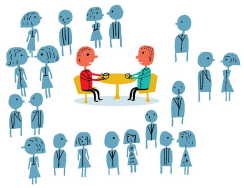
> Practices are patterns of responsiveness to each other and the world, mediated by social meanings and signaling mechanisms [including the apparatus of meaning], that enable members of a group to communicate, coordinate, and manage things taken to have value.

I use the term "cultural technē" for the social meanings and signaling mechanisms, and "resources" for what is regarded as having positive or negative value. (See Haslanger 2018, 2023; Sewell 1992.)

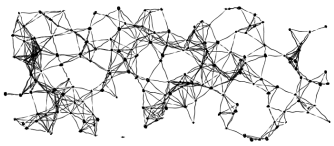
Relations and Networks: Social practices, as I have described them, are embodied patterns of interaction between agents and the world, guided by a cultural technē. These establish social relations. The practice of teaching establishes the relation between student and teacher. The practice of parenting establishes the relation between parent and child.[3] Such relations are embedded within other relations, and some clusters of practices constitute institutions.[4] For example, the practice of teaching involves not just a relation between teachers and students, but also between teachers and administrators, parents, the school building, and classroom supplies, and of course, especially in public schools, the

[3] Practices can also interpellate or subjectivate those who occupy the relational positions.
[4] There are multiple ways of using the term 'institution,' and I don't want to defend a particular account of institutions here. My point is simply that practices cluster in different ways.

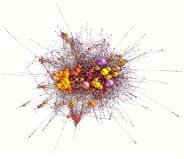
state. A cluster of local practices can make up a particular school, or more broadly, a local school district; these are connected to broader clusters at the state and federal level. Networks of relations form structures.



Practice



Structure



System

Systems: It can be helpful to think of systems as dynamic processes. A primer on systems biology makes this clear:

> While an understanding of genes and proteins continues to be important [in systems biology], the focus is on understanding a [biological] system's structure and dynamics. Because a [biological] system is not just an assembly of genes and proteins, its properties cannot be fully understood merely by drawing diagrams of their interconnections. Although such a diagram represents an important first step, it is analogous to a static roadmap, whereas what we really seek to know are the traffic patterns, why such traffic patterns emerge, and how we can control them. (Kitano 2002, 1662)

In other words, aspects of a system (physical or social) may be represented in a static model, but the relations that form the structure of a dynamic system constrain and enable action and evolve over time. If we are keen to promote social justice, it can be helpful to understand how social systems reproduce themselves and evolve. There is a temptation to think that the dynamics are to be found in hearts and minds, and we should focus on psychological interventions. I'm not denying that changing minds matters, but systems, in general, are materially and culturally structured to maintain themselves and agents are shaped to enable this. However, because systems are dynamic, they do not achieve pure homeostasis. The image should be a spiral rather than a circle (it is not a snake chasing its tail).

C*omplex dynamic systems* are everywhere: they include hearts, brains, ant hills, weather systems, economies, and ecosystems. Key here is that complex systems spontaneously self-organize *without external intervention or central authorities.* In societies, some individuals and institutions have much greater power than others), but the system sustains itself (as long as we more or less do our part). To grasp the extent of this point, we should consider complexity a bit further.

A *simple system* (very roughly) is one in which the behaviors of the whole can be explained or predicted by reference a sequence of regular (linear) operations on its parts. (Simon 1962; Bechtel 2011) Examples of simple systems include thermostats, clocks, calculators, printers. *Complex systems*, in contrast, are not straightforwardly decomposable into independent parts, the operations on the parts are not necessarily linear, and they are self-organizing and stable due to feedback loops (Ladyman et al

2013). Complex systems can appear chaotic because the interactions between the parts are non-linear and unpredictable. But nevertheless, the whole displays patterns and regularities.[5]

Co-integration

To make progress in understanding complexity, let's start with a simple example. Following Murray (1994), imagine that Suzy has gone to a bar with her dog and leaves the dog tied outside. Suppose her dog slips its leash and wanders in the neighborhood. Suzy leaves the bar after having a few too many drinks and, wondering where her dog is, heads out towards home. Suzy's and the dog's paths may seem utterly random – the dog is distracted by every smell, Suzy is wandering, befuddled. However, the dog doesn't want to get too far from Suzy, and Suzy doesn't want to get too far from the dog. When the dog barks, Suzy moves closer to the sound; when Suzy calls out, the dog adjusts its movements towards her. The relationship between the dog and Suzy is not fixed – the dog is not on a leash – but they are probabilistically correlated, or in other terms co-integrated.

The example illustrates several things. First, in some cases, apparent randomness in the behavior of an individual entity is revealed as not random once we find it to be part of a whole (Suzy + dog). This does not mean, however, that the behavior becomes completely predictable. Second, the behavior of each individual is explained (in part) by their relation to each other, i.e. to their being parts of the whole. In the case of Suzy and her dog, the two "corrected" their paths to approach each other: they are co-integrated. However, if the dog was following Suzy, but Suzy was oblivious to the dog, the dog/Suzy paths would not be co-integrated. What matters for integration is each part's dispositional responsiveness to the behavior of the other part(s). This is one way to draw the boundary between systems and their environment (which may be another system): the environment is not co-integrated with the system, because although the environment affects the system, the system does not have the same kind of impact on the environment, e.g., the weather can affect the trajectory of the dog and Suzy, but the dog and Suzy do not affect the weather.

Like ecosystems, societies are made up of sub-systems that work together to sustain the whole. In order for a society to develop and maintain itself, it must find ways to accomplish certain tasks. There must be ways to manage and coordinate, among other things: food production and distribution; sex, reproduction, and childcare; education and the division of labor; health, aging, and death; shelter and defense; collective decision-making, arbitration, and leadership; leisure activities. Larger and more complex societies will also need monetary systems, transportation systems, etc. Sub-systems are developed to accomplish these various tasks, and (at least many of) these systems are co-integrated. A social system may evolve in ways that can be explained only by multiple factors, including input from the environment, the interaction of multiple dynamic forces or principles, and contingent behavior of parts.

[5] Such regularities can be modeled computationally by considering individuals (which may or may not represent human agents) with certain structured options and probabilities distributed across these options, within a network topology. By running repeated simulations, emergent phenomena can be identified and by tweaking options and probabilities, for example, we can see how patterns change.

Two recent examples of co-integration include the criminal justice system's co-integration with the immigration system (sometimes called "crimmigration") and with the foster care system. Mendoza (2020) characterizes crimmigration:

> Crimmigration is a term used by migration scholars to refer to three areas in which criminal law enforcement and immigration law enforcement are problematically conflated. The first is when criminal convictions come to have immigration consequences, such as a revocation of a visa or green card. The second is when immigration law violations come to have criminal-style punishments. The third is when the tactics sanctioned for criminal law enforcement are commandeered for the purposes of performing immigration enforcement or vice versa. (2020, 2)

And Dorothy Roberts has documented, in detail, the co-integration of child protective services (CPS) and criminal justice:

> The symbiotic relationship between law enforcement and child welfare agencies systematically buttresses a police state in Black communities by triggering investigations into family life, reinforcing family surveillance with armed might, and threatening families with both prison and child removal. (2022, 205)

Poverty, because it is correlated with difficulty in providing for a child's basic needs, itself is considered a basis for child removal (Roberts 2022, 30). CPS investigates Black homes almost twice as often as White homes, and in some urban areas, 72% of Black children have been investigated.[6] (My children are Black, and I, personally, have been reported and investigated more than once.) Moreover, foster care alumni are at high risk for involvement with the criminal justice system. A recent report claims that "one quarter of foster care alumni will become involved with the criminal justice system within two years of leaving care…The foster care-to-prison pipeline particularly affects youth of color, LGBTQ-identified youth, and young people with mental illnesses"[7] Of course involvement with the criminal justice system affects one's employment options and life prospects, generally. Moreover, mothers, especially single mothers, are vulnerable, being the ones most often responsible for children.

In these examples, family relations are managed, and citizenship rights and freedom are curtailed through practices that rely on gendered, racialized and ethno/national social meanings. These practices, in turn, produce deep economic and civil marginalization. This is happening at the meso level of integrated sub-systems of practices with patriarchal, capitalist, and White supremacist dynamics.

One might ask, however, how are systems individuated? On the view I endorse, how we identify a system will depend on the question we are asking.[8] Systems are relevant when we are considering how an effect is produced through a process. Parts of a system and their interaction/interdependence contribute

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[6] Roberts (2022, 45). "more than half of Black children (53 percent) are subjected to a CPS investigation at some point during their childhoods — almost twice the lifetime prevalence for white children (28.2 percent). A 2021 study that focused on data from America's largest counties revealed even higher rates of investigation in some urban areas. For example, the study estimated that 72 percent of Black children in Los Angeles County will endure a CPS investigation during the course of their childhoods."

[7] Juvenile Law Center (2018) https://jlc.org/news/what-foster-care-prison-pipeline

[8] See Cummins 1975. Thanks to Hochan Kim and Katharine Jenkins for helping me clarify this point. I endorse an erotetic approach to explanation according to which explanations are answers to questions and should be evaluated in light of the question posed. See Haslanger (2016).

to bringing about the effect. To identify a system, relevant questions to ask are *what resource* is the system managing, what parts are involved, and *which dynamics* are responsible for the co-integration of parts that enables it to sustain itself and evolve.[9]

In social systems, resources are interpreted *as such* through a frame of social meanings. As a result, the same "thing" may serve as a resource within and be managed by different sub-systems. For example, as school may be part of an educational system, but also a health care system (school nurses are a front line in monitoring child health and safety), a criminal justice system (school staff are mandated reporters and increasingly security guards monitor schools for criminal activity), and a real estate system (housing prices reflect neighborhood school quality). Another way to put this is that systems do not necessarily "saturate" a social space (Walby 2007). As a result, the dynamics of multiple systems (education, health care, criminal justice, real estate) will interact.

To recap: on the account I have just sketched, social structures are networks of relations that distribute (produce, dispose of) *resources*, i.e., things taken to have (+/-) value. Some of these resources are straightforwardly material, such as food and shelter, but they also include practices that distribute more intangible resources such as knowledge, time, health, labor, citizen rights, etc. Structures provide the framework for a system, and a system adds dynamics. But how should we understand these "dynamics"?

Dynamics

The dynamics are the principles that explain the process in question. In the case of ecosystems we may look at fluid dynamics; in a protein, chemical dynamics. For example, if we are interested in how blood is oxygenated, we will focus on the circulatory system, the heart and lungs, and the ways they interact to distribute oxygen through the body.

How we should understand the interaction between different dynamics is an ongoing issue. Consider the debate over single- and dual- (or triple-) systems theory. In socialist feminist theory, there have been longstanding debates over whether we should adopt a dual- or triple-system model of our current social formation. The question often takes the form: What is the relationship between capitalism, patriarchy, and White supremacy? Is it useful to think that our social formation is the single system: *capitalism?*

Single-system theorists have tended to think there must be a single overarching dynamic that explains the system's workings. The most common suggestion is that the system evolves according to a "capitalist logic."[10] The capitalist logic explains not only production, but expropriation, social reproduction, environmental degradation, and undemocratic politics.

[9] In some cases we would want a more fine-grained individuation that also depends on the kinds of relations that make up the network, e.g., different political systems distribute power and basic goods through different (democratic, authoritarian, monarchical) relations.

[10] See, e.g., Fraser 2022. It is never quite clear (to me) how to characterize precisely the capitalist logic – partly because "logics" work at different levels (micro, meso, macro). But it is not crucial to specify this in detail here.

But why assume that a complex system must have only one dynamic, or one "logic" (or one dominant one)? In the context of organizational theory,

> The institutional logics approach views any context as potentially influenced by contending logics of different societal sectors. For example, the health care field is shaped by the institutional logics of the market, the logic of the democratic state, and the professional logic of medical care. (Thornton & Ocasio 2008, 104)

So one source of complexity in systems is the interaction between different dynamics embedded in culture (or in my terminology, the cultural technē). Understanding the dynamics of a social system will also require attention to "logics" beyond capitalism.

William Sewell, Jr. (2005) makes this point:

> …culture has a semiotic structuring principle that is different from the political, economic, or geographical structuring principles that also inform practice. Hence, even if an action were almost entirely determined by, say, overwhelming disparities in economic resources, those disparities would still have to be rendered meaningful in action according to a semiotic logic – that is, in language or in some other form of symbols. (2005, 48)

Semiotic logics form broad ranging nets that take highly contingent forms, e.g.,

> …the network of semiotic relations that make up culture is not isomorphic with the network of economic, political, geographical, social, or demographic relations that make up what we usually call a "society." A given symbol – mother, red, polyester, liberty, wage labor, or dirt – is likely to show up not only in many different locations in a particular institutional domain (motherhood in millions of families) but in a variety of different institutional domains as well (welfare mothers as a potent political symbol, the mother tongue in linguistic quarrels, the Mother of God in the Catholic Church). Culture may be thought of as a network of semiotic relations cast across society, a network with a different shape and different spatiality than institutional, or economic, or political networks. The meaning of a symbol in a given context may therefore be subject to redefinition by dynamics entirely foreign to that institutional domain or spatial location…(2005, 49)

This suggests that the cultural technē is one source of dynamics through the "logics" that guide our agency in practices. But given that practices shape and are shaped by the material world, cultural logics interact with the dynamics of physical systems, e.g., the physical systems that sustain living bodies, the environment, and the built environment.

As mentioned above, I think most useful way to capture the structure of our contemporary social formation is by considering meso-level material sub-systems rather than "patriarchy" or "White supremacy," or "capitalism." One reason, that I won't discuss in detail here, is that I believe it provides a better model for understanding the phenomenon of "intersectionality." Social positions occur within meso-level practices, and all of these practices are affected by dynamics of gender, race, ethnicity, age, nationality, etc. One is interpellated to occupy positions that are the result of interacting dynamics; gender, race, and other categories are emergent patterns in these positions. (See Haslanger 2024.) Moreover, I think that the examples of cointegration in the previous section support the idea that the

cointegration of meso-level practices are where we should be focusing our attention in order to address systemic injustice.

However, there is reason to postulate a single system because the many meso-level sub-systems are co-integrated. In other words, co-integration happens both within sub-systems and across sub-systems. This is why I claim that our social formation is capitalist, patriarchal, White supremacist, ableist, speciesist, heteronormative, bionormative, etc.: these are the dynamics in play. Because the dynamics of the system are entangled and complex, our efforts at transformation must take that into account, and prioritizing capitalism as our target – although there is tremendous power behind it – is a mistake.

3. Social Change

I have spent so much time on social ontology that I have run out of space to talk about social change. However, I will still try to say a few things. Forgive me for using bullets to do so efficiently.

- It is through social practices that we shape the structures of social systems. To change a social practice, we can change the relevant part of the cultural technē (the "logic" for that practice, thus the interpretive tools *and* the dynamics), or the material conditions (what is available to serve as a resource). We can also use unexpected material disruptions (natural disasters, pandemics) as opportunities for intervention, e.g., to create new social networks (such as mutual aid (Spade 2020)).
- Non-conformity and resistance are important strategies for changing both the technē and the material conditions. These are best done collectively. Drawing on Erik Olin Wright's work, I would say that a ruptural vision may be necessary, but long-term interstitial and symbiotic efforts are necessary to achieve transformative change. Laws and policy are part of the cultural technē and change in such formal tools can change practices. But for legal intervention to be transformative, it depends on social movements to initiate it, to achieve uptake, and to prepare for the consequences. Because in liberal societies, the state can only reach so far, social movements that do not rely on the state's coercive power are also necessary (the state can't dictate who does the laundry).
- Social movement work comes in many forms. I am especially interested in a model that begins by building solidarity through collective narrative and intervention by training in co-design. I have much more to say about this and how it is adaptable in a variety of contexts and is agency enhancing. However, we should also look for tipping points. At a tipping point, small changes can make a big difference: these are called "cascades". There is quite a bit of work on how systems are self-reinforcing, but also how cascades develop in the social domain; this is done with the help of modeling I mention in fn. 5.[11] It isn't just random when and how complex systems change, and isn't totally unpredictable, but it does not happen deterministically.

[11] Some examples: Preferential attachment network formation (https://www.netlogoweb.org/launch#https://www.netlogoweb.org/assets/modelslib/Sample%20Models/Networks/Preferential%20Attachment.nlogo) Sheep/wolf predation (https://www.netlogoweb.org/launch#https://www.netlogoweb.org/assets/modelslib/Sample%20Models/Biology/Wolf%20Sheep%20Predation.nlogo) To view the models, click "setup" and then "go". Information about the model at the bottom under "Model Info."

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