Self-Organizing Systems
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Introduction

The sciences of chaos, complexity, and nonlinear dynamics have shaped theory and practice in social sciences in recent years. The reason is easy to see—conditions are changing, so human systems are behaving differently. Boundaries are more fluid, so external forces have unexpected influence. Diversity is increasing, so systems are less predictable and stable. Connections are faster and more massively entangled, so relationships between causes and effects are more difficult to see and control.

In all, human systems at all levels are becoming less controllable and less predictable. Human systems dynamics is an emerging theory and practice that draws lessons from these new sciences to see patterns as they emerge in social systems, to understand their implications and limits of certainty, and to take courageous action to influence patterns toward greater productivity and performance.

This short paper introduces some fundamental features of complex, self-organizing systems, including:

- Self-organizing in human systems
- Patterns
- Scaling
- Co-evolution
- Why now?
- Questions and implications

For more information about these or other facets of the complex dynamics of human systems, contact us at the Human Systems Dynamics Institute.

Self-Organizing in Human Systems

All human systems are in the process of self-organizing all the time.

When people are constrained, the process of self-organizing may not be apparent, and social systems may seem stable or static. Consider, for example, convicts in prison. Their locations, identities, and interactions are restricted, so spontaneous change happens seldom, and when it does it is hard to detect or control.

On the other hand, when people are unconstrained, self-organizing processes generate random, constantly surprising interactions, so no discernable patterns appear at all. Consider, for example, young people at a political rally. The group location may be defined, but individual positions are unpredictable; each person considers him/herself to be unique; and interactions are usually momentary and random. Because our social and cultural systems are ubiquitous, it is difficult to imagine a situation where groups of people maintain random, unpatterned behavior for any length of time. Very quickly, people begin to interact and patterns begin to form.

In between the over-constraint of the prison and the under-constraint of the rally lie the conditions for observable, self-organizing pattern formation. Active self-organizing processes can be observed in many situations: traffic patterns, children on a playground, election year politics, people at a party, interesting people at a workshop, the stock markets, organizational mergers and acquisitions, delivery of services, manufacturing processes, scientific research, family relationships, and on and on.

In each of these cases, the conditions that shape the system interactions are neither completely constrained or completely absent. In recent years, we have encountered situations where pattern formation was particularly fast, powerful, and surprising. We find these situations especially interesting because they are most difficult to explain from our traditional, non-self-organizing world views. The HSD assumption is, however, that we can understand these remarkable cases best if we consider them as merely special cases along a continuum of self-organizing processes, some of which are already familiar and tractable for us.

To move ideas of self-organizing from mere description to explanation requires us to operationalize the concept of "patterns."

Patterns

Self-organizing processes are initiated in existing pattern(s) and generate new pattern(s) over time. Consider the case of the 99% and the Arab Spring. When the first on-line conversations began about either of these movements, there was an existing pattern that already existed. The self-organizing processes of communication established a series of new patterns over time. Whether you judge the new patterns as productive or destructive is a matter of perspective, but the transformation of the patterns over time is undeniable. To help make sense of these self-organizing transformations, we define a pattern in a human system as: *Similarities, differences, and relationships that have meaning across space and time.*

Similarities in human systems give them identity and stability. Examples are plentiful in public policy and conflict situations. Racial, ethnic, political, and economic similarities establish coherent groups with recognizable and persistent patterns of behavior. Without some level of similarity, human systems would never move out of the random, unorganized dynamic at all. With too much or intractable similarity, groups find it difficult to adapt to environmental changes. Technically, in terms of the CDE Model, we refer to similarities in human systems as one of the conditions for self-organizing—the container (C).

Differences, on the other hand, serve two purposes in self-organizing systems. First, they articulate the shapes in the pattern. Looking at a satellite photo of an area, the differences in color and shape give information about the area. They define the space and distinguish one part of the territory from another. In human systems, differences in religion, economic status, party loyalty, family ties, and so on establish the patterns of collaboration or competition at a particular place and time. In addition to defining the pattern, differences establish tension, and tension creates the potential for change. Without difference, a system—either physical or human—will not change. Physicists call this state of homogeneity "entropy," and it signals the end of the useful life of the system. The presence of difference, however, establishes a condition of asymmetry or disequilibrium that motivates and accommodates the need for movement. This condition for self-organizing is included as difference (D) in the CDE Model.

Relationships across differences are the final condition that allows a pattern to hold meaning. When groups are not in contact, if they have no connections between or among them, then no shared pattern of behavior will emerge. On the other hand, interactions in the form of financial transactions, personal relationships, family ties, professional interactions, or physical threat and endangerment will serve as a fuse to release meaning in a current pattern or

the potential for transformation to new self-organizing patterns. This final condition for self-organizing is included as exchange (E) in the CDE Model.

These three conditions—container, difference, and exchange—are both necessary and sufficient for self-organizing process. Their states determine the path and speed of self-organizing processes, but the outcomes are still unknowable and beyond control. The reasons for this fundamental unpredictability are simple.

First, any human system encompasses an infinite number of features that can function as containers, differences, and/or exchanges, but not all of them are relevant at any given moment. A community, for example, can focus on its race, economic status, location, architecture, age, shared history, religion, or any other coherent, shared pattern. Though one might see and change one set of conditions in order to influence a self-organizing process, another one of the conditions may spontaneously move to the fore. For example, I worked with a world-wide protestant denomination. Their intention was to articulate a shared faith in order to build a stronger community, but different attitudes regarding social justice emerged spontaneously and disrupted the predicted path.

The second factor that precludes prediction and control in self-organizing systems is that the three conditions are coupled in nonlinear and unpredictable ways. Tightening the container will have some effect on the relevant differences and the internal exchanges, but the relationships are unknowable. Focusing on a different set of more relevant differences or altering exchanges will affect the other two conditions, but the effects cannot be predetermined.

The pattern is both the raw material for and the product of self-organizing processes. The systemic similarities, differences, and relationships at any one point in time establish the potential for and likely outcomes of transformation at any later point in time. The outcome of one step then becomes the foundation for the next. This iterative, emergent process has the potential to generate radically surprising phenomena or to lock a system into persistent inaction. Both are self-organizing processes that depend on the initial conditions unique to the people, place, and time of the initial engagement.

Scaling

One of the most interesting and powerful aspects of patterns in self-organizing systems is that they are scaled—the same patterns tend to appear at multiple levels of organization. Many natural systems demonstrate scaling. The most common example is broccoli. A stalk of broccoli looks like a branch

of a stalk, which looks like the part of a branch of a stalk, and so on. The same self-similarity or family resemblance can be discerned across levels of the structure. Similarity across scales gives stability and coherence to structures that might otherwise be fragile.

The same phenomenon can be observed in human systems. In the US, for example, self-determination is a strong determinant of relevant similarities, differences, and relationships in national, corporate, state, local, and personal contexts. The same scaling phenomenon influences behavior in Iraq, but the patterns that are repeated at many levels are different that those we are accustomed to in the US.

Scaled patterns are often referred to as the constituents of "culture," but how do you change culture? Self-organizing systems can provide a clue. When culture is operationalized as "similar patterns appearing at multiple levels of scale," and when patterns are operationalized as "similarities, differences and relationships that have meaning," new options for understanding and influencing cultural difference become obvious.

When one becomes sensitive to scaling in human systems, it is easy to understand how seemingly small interventions can have unexpectedly large influence. A pattern started in one place at one level of scale may be spontaneously replicated and amplified at other levels of organization. On the other hand, persistent patterns in levels above or below an explicit intervention can form a barrier to change as it damps insipient transformation. The scaling power of a system either to reinforce or erase an emergent pattern is the reason that an individual cannot be seen as a root cause of a self-organizing pattern. The self-organizing capacity of the environment (as explained by the most influential containers, differences, and exchanges) will determine whether or not a particular event will trigger a self-organizing explosion of change. If, for example, the roles and responsibilities, ranks and expectations, communication methods and habits of an institution replicate patterns of control and constraint at all levels, then individual creativity will not easily emerge as a dominant pattern.

Patterns in human systems are also reinforced and disseminated through a process called "co-evolution."

Co-Evolution

Biologists are well aware of systems that co-evolve. A virus adapts to live in the gut of the spider, and the spider evolves to draw nutrients from the digestive byproducts of the virus.

Co-evolution can be observed in human systems, too. Successful pioneers in the 19th century American West adopted and adapted a wide range of dietary and cultural patterns from the American Indian. Youth gangs learn the basics of drug dealing from their colleagues to sustain their communities. Tastes in music and dress are informed by peers and celebrities. Political campaigns co-evolve with each other as both search for patterns that will appeal to a complex electorate. Conflicts escalate as individuals and groups shift their strategies to respond to the behaviors of others.

When human system interactions are seen as opportunities for co-evolution, the options for meaning making and action shift, and new strategic paths may emerge.

Why Now?

It would be easy to ask, "If human systems have always been self-organizing, why are we just beginning to notice?" This, too, depends on the conditions for self-organizing. When most of our containers were physical rather than virtual, the speed and expanse of our self-organizing processes were minimal. In our new virtual world, information-based containers can be ambiguous, invisible, and highly volatile. When our national and regional patterns were isolated, our diversity was invisible. In complex systems, homogeneity inhibits self-organizing, so the potential for emergence was constrained. Finally, newspaper, train travel, public post, and telephone support slow exchanges, and slow exchange curtails the capacity to self-organize. Today, all of the conditions for self-organizing have shifted, so we experience more, faster, broader, and more radical self-organizing processes than ever before in human history. As a result, we observe emergent phenomena that seem to appear from no where, are powerfully constructive or disruptive, and defy prediction. From our old world views of linear causality, prediction, and control, these phenomena seem to be magic. From the new world view of self-organizing dynamics, they can be understood and influenced, but our expectations for prediction and control have to change. This new emergent and unpredictable world feeds the urgency of your inquiries about self-organizing systems and their dynamics.

Questions and Implications

These thoughts are simply a beginning of a potentially long and fruitful conversation. Some of my outstanding questions include:

- How do we re-define power in the context of self-organizing systems? How is it same as and different from "soft" power?

- How do relationships among agents (and with an emergent whole) change when human systems are actively self-organizing?
- What is the process for distinguishing among the organized, self-organizing, and unorganized dynamics in human systems?
- What will teaching and learning happen differently in unorganized, self-organizing, and organized dynamical situations?
- How can these ideas of dynamical change be introduced into decision making and action in strategic arenas?
- What are the patterns that are scaled across cultures that instigate and/or insulate healthy and productive interactions?
- In what ways would tools and methods from human systems dynamics inform understanding and action in the future of teaching and professional development?
- How do other concepts from human systems dynamics appear in the patterns of decision-making and action related to the war of the future?
    - Adaptive action process
    - Agent-based modeling
    - Attractor patterns
    - Bifurcation path to chaos
    - Dissipative structures and far-from-equilibrium dynamics
    - Fitness and nK landscapes
    - Scale-free networks
    - Self-organized criticality and the tipping point
    - Short lists of simple rules
    - Static, dynamic, and dynamical change
    - Sustainability in self-organizing systems

Conclusion

Human systems are self-organizing, and the more we understand about their self-organizing dynamics the more effective we can be in our thought, speech, and action. I look forward to our continuing conversation and applications of our work in human systems dynamics to your complex and urgent challenges.