

COMPLEXITY 101: CONCEPTS AND TOOLS FOR OD PRACTITIONERS

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Introduction

Many OD practitioners have heard about chaos theory and complex systems. You may have ideas about how these emerging sciences relate to your OD work, but do these insights inform your day-to-day interactions with clients? Responsible application of chaos and complexity theories to real world practice requires an understanding of the basic principles, an openness to new and sometimes counter-intuitive approaches, and a commitment to exploring and experimenting with new tools and techniques.

A complex adaptive system is a collection of semi-autonomous agents that interact with each other and whose interactions generate system-wide patterns. Agents may be individuals (in teams), teams (in a department), departments (in a company), companies (in an industry), or industries (in an economy). At all of these levels, the entities interact to form new patterns that are different from the sum of the parts. Teamwork, corporate culture, productivity, creativity are all examples of the kinds of system-wide patterns that can emerge when humans work together as effective complex adaptive systems. The sciences of complexity and complex adaptive systems investigate and document the surprising behaviors that are characteristic of such emergent systems.

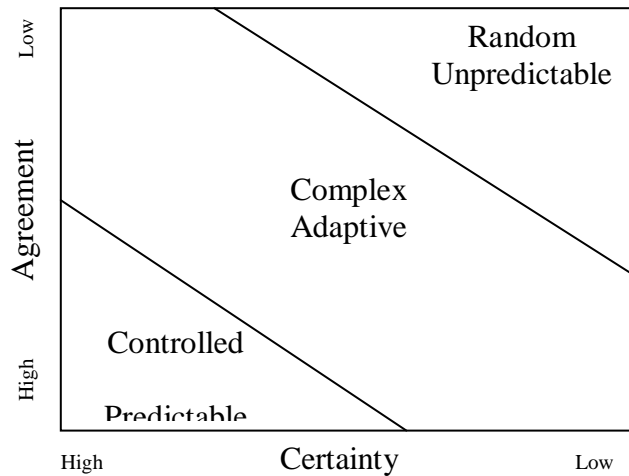
This paper presents a brief introduction to some of the fundamental ideas of complexity and describes ways in which these ideas can inform your OD practice.

An exhaustive catalogue of complexity concepts is beyond the scope of this paper. Theoreticians disagree about whether an exhaustive list is even possible, given the assumptions of the field and its current stage of development. Rather than addressing these etherial questions, this paper will introduce some of the concepts that we have found most helpful in working with individuals, teams, and organizations. We will address: Three patterns of behavior in dynamical systems, sensitive dependence on initial conditions (butterfly effects), attractors, fractals, self-organized criticality, generative relationships, agent-based models, scaling, fitness landscapes, and significant differences.

Three Patterns of Behavior in Dynamical Systems

Complex systems display a wide range of behaviors. At some times and in some parts, the system may be perfectly predictable and structured. Under other circumstances, the system may be completely unpredictable and without any pattered behavior. At still other times and places, the system may exhibit complicated patterns of similarity and difference, though individual behaviors

are beyond prediction. Two variables that help define the predictability of the system are the amount of agreement among the agents and the level of certainty in the environment. The following diagram shows how these two variables interact and how the system dynamics respond.



When both the agreement and level of certainty in the system are high, the system will behave in traditional ways. Control is possible, and the behaviors of the system can be predicted reliably. When agreement and certainty are low, on the other hand, the system is completely out of control, and no one can guess how individuals or groups will behave. At medium levels of agreement and certainty, the system behaves in complex adaptive ways. System-wide patterns emerge, and a variety of characteristic behaviors begin to appear.

Each of these dynamics requires different OD tools and techniques. The controlled, predictable dynamic allows clear outcome evaluation and rigid project management approaches. The random dynamic requires humor, storytelling, and containment of anxieties. The complex, adaptive dynamic self-organizes into patterns and is the subject of research and practice in the fields of chaos and complexity sciences. The rest of this paper describes some of the characteristic behaviors that emerge from complex adaptive systems when they are in this self-organizing realm.

Sensitive Dependence on Initial Conditions (Butterfly Effects)

One of the most familiar patterns in a complex system is known as the butterfly effect. In a system that is balanced at the edge of complexity, a very small cause can have an enormous effect. The classical example is a butterfly flapping its wing in Argentina and resulting in a hurricane off the coast of Florida--small cause and large effect. The technical name for this phenomenon is "sensitive dependence on initial conditions."

You are probably familiar with situations in teams and organizations where a very small incident results in a complex combination of unpredictable results. That is the butterfly effect at work. To deal effectively with butterfly effects, you can:

- Expect them when you least expect them
- Don't search for a root cause of a complex outcome
- Intervene to amplify positive patterns of behavior
- Intervene to damp negative patterns of behavior

Attractors

An attractor is a pattern of behavior exhibited by a complex adaptive system over time. If you track the behavior of a system long enough, you will see one of four emergent patterns, each of which is a type of attractor.

- All the parts of the system move toward the same endpoint. This is a point attractor. An example occurs at quitting time--everyone in the building moves toward the exit, so the pattern of motion is toward a single endpoint.
- The parts of the system repeat the same behaviors at regular intervals. This is a periodic attractor. A payroll system is a good example of a periodic attractor because the same behaviors are repeated at regular intervals.
- The behavior of the system stays within observable bounds, but within those bounds anything is possible. This is called a strange attractor. Corporate culture is sometimes used as an example of a strange attractor. The acceptable bounds of behavior are known, but within those bounds, individual employees have freedom to make choices.
- The parts of the system seem to move without connection to or regard for other parts of the system. This is called a random attractor. It is hard to think of examples of true random attractors in human systems because people are almost always connected to each other in some way. You can imagine, though, that customer service in a retail establishment might be more random than some other organizational functions. Who knows what the next customer will request?

In complex systems, these four types of attractors allow you to recognize and work with patterns of behavior, even if you cannot predict or control the behaviors of individuals or groups over time. In your OD practice, you can use an understanding of attractors to:

- Generate interventions that shift attractor patterns
- Anticipate how a system will respond to an intervention
- Choose actions that work with, rather than against, the predominant attractor pattern

Fractals

A fractal is a geometrical pattern that is characteristic of complex systems. It is special because of the way it is created and because of the way it looks as it emerges.

A fractal is generated by repeatedly solving a nonlinear equation using the answer from the last cycle as the beginning for the next. Computers complete thousands of solutions, evaluate and plot the results to construct what we see as fractal images. This process is similar to the ways that core values shape organization-wide behaviors. Each individual uses the core values to solve a problem. Over multiple problems and multiple solutions, corporate-wide patterns of behavior emerge.

The completed fractal image incorporates multiple copies of the same (or nearly the same) pattern. The copies are of different sizes, different places, and different relationships to each other. The self-similarity across the fractal, however, serves as a kind of "family resemblance" in the figure. In organizations, fractal patterns provide a sense of identity and shared experience for individuals and groups. To use fractals in organizational contexts:

- Identify the short list of simple rules that shape repeated patterns of behavior (e.g., competition, humor, quality, cooperation) and amplify or change those rules
- Compare the fractal patterns in different teams, departments, companies to understand why they work well together or not
- Ask groups to draw for themselves the patterns that repeat across their organizations

Self-Organized Criticality

Tension in complex systems accumulates over time. Small changes cause invisible changes, but over time tension builds up until the entire system shifts abruptly. This process is called self-organized criticality. One folk example of this phenomenon is the straw that broke the camel's back. Many straws preceded the critical one, but when it fell, so did the camel. Some people talk about self-organizing criticality in terms of a "tipping point."

You observe self-organized criticality in organizations when long-term change efforts seem to yield no results, then, all at once, the system shifts for no apparent reason. Each in the series of interventions built up the tension within the system and set the conditions for an unexpected cascade of change. You can use the concept of self-organized criticality to:

- Help the client be patient when it seems nothing is changing
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- Unfreeze the system by building entropy beyond a critical threshold to induce change.

Generative Relationships

Complex adaptive systems depend on rich and transforming relationships among system participants. As the parts of a system work and play together, their interactions generate new system-wide possibilities and behaviors. You see generative relationships at work when a collection of individuals focus on a single purpose and learn to work as a team. The team is what we recognize as the generative capacity of the relationships among the individuals in the team. Just as a pot of boiling water generates the bubbles and convection currents as it is transformed into steam, groups of individuals generate new behaviors as they function together under the right conditions.

- You can use the concept of generative relationships to:
- Identify emerging leaders who make notable and specific contributions to the group task.
- See how the interaction at one level of an organization affects the performance at other levels
- See how ideas self-organize into new insights that are shared by the team.

Agent-Based Models

The behavior of a whole can emerge from the apparently autonomous actions of individual agents within the system. Nature displays agent-based behaviors when a swarm of bees build a hive, reproduce, and locate food. Individual bees are following simple rules. Together the swarm is able to solve problems that no one bee has planned and that none could attempt alone.

In organizations, individual employees can function as independent agents. If the rules they follow are crafted well, then the agents together are able to generate a whole that is greater than the sum of the parts. You can use the concept of agent-based models to:

- Reflect on the simple rules that drove behavior in the past
- Articulate minimum specifications for organizational innovations
- Reinforce the nature of freedom and constraint within an organizational culture

Scaling

Complex systems incorporate multiple levels of organization, which are massively entangled. Individuals, teams, departments, social groups, identity groups, professional affiliations all form nested subsystems within our organizational complex systems. When a complex system is healthy, the same patterns are repeated within each of the multiple contexts and the contexts interact smoothly as individuals move from one to another. Scaling describes the fact that patterns of identity appear in various places and levels within an organization. Scaling provides system-wide and individual definitions of identity and productivity that allow the whole to function smoothly, even when specific environmental changes cannot be predicted.

As an OD professional you can use scaling to:

- Reinforce shared identity within an organization
- Value both similarities and differences among individuals, professional groups, identity groups, and levels of management
- Help managers understand why their behavior has rippling effects throughout the organization.
- Understand that changing incentives for individual agents can change the system.

Fitness Landscapes

One of the ways that scientists think about complex systems is with the metaphor of fitness landscapes. These landscapes, like those in the physical world, include peaks of successful performance (sustainability) and valleys of low productivity (death). On a rugged landscape, there are many possible successful choices, but none rises clearly above the others, so individuals can choose one or another without meeting with direct competition. On a single-peak landscape, there is only one successful strategy and everyone must move toward it to survive.

By recognizing the shape of the fitness landscape, the OD professional can identify patterns of competition and cooperation in an organization and help a group develop adaptive strategies to work most effectively in their unique environments. You can use fitness landscapes to:

- Help individuals understand their environments
- Establish options for action between and among individuals and groups
- Support a sense of hope and efficacy in individuals

Significant Differences

Differences drive change in a complex system. In the same way that a difference in altitude results in water flowing downhill, differences in power, position, education, standing, or wealth establish the conditions for change in human systems. Within any group, many differences can be

identified, but not all of them are significant. By selecting and focusing on the "differences that make a difference," an OD professional can help shape the speed and path of change within a team or a group.

You can use significant differences in your practice to:

- Surface and resolve conflict
- Focus energy on differences that are most productive
- Provide a judgement-free way to talk about cultural or values differences
- Design interventions that focus organizational energy in productive directions

Conclusion

This brief introduction has outlined some of the characteristic behaviors of complex adaptive systems and pointed out ways in which these concepts can support the work of the OD practitioner. Our expectation is that many of these patterns are familiar to you, as an experienced professional. It would be surprising if they were totally new because you work everyday in systems that are complex and adaptive. The power of the complexity approach is that it provides language, metaphors, and approaches that embody your best intuitions about how individuals and organizations operate. When these intuitions are articulated, they can be optimized, shared, and used to their best advantage.

This paper could in no way represent all of the breadth and subtlety of the entire field of complexity. Our hope is that it sparked your interest and whetted your appetite for more investigation and experimentation in the field. We suggest the following resources for further learning.

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