

Complexity Theory Applied to Planning

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Research Paper
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"No problem can be solved from the same consciousness that created it."

-Einstein

Introduction:

"Our theories determine what we measure."

-Albert Einstein

Were we to assume that planning is a linear process, we could make predictions and guarantee success. Unfortunately, planning is not that simple. If we lived in a country with a dictator, linear analysis might be somewhat applicable; however, the fact that we live in a democratic free-market society makes linear assumptions impossible.

Current theories rely upon scientific method assuming that with enough data we can make decisions that are most likely to result in positive outcomes. Some of the problems with approaching planning with this outlook are:

- 1) We can never know everything.
- 2) We are assuming a static solution is ideal.
- 3) We assume that planning is linear.

Complexity theory allows us to view planning as a part of a greater whole. By thinking about planning as a living or dynamic process, we are able to let plans evolve over time. Chaos and stability are then considered necessary parts of the process. And as a result, our evaluations of outcomes are far more complex and wide reaching as well.

With this paper I hope to provoke thoughtful reflection about how we evaluate and determine success in the planning community. Complexity theory has a tendency to raise questions regarding "known truths" and that which we perceive to be reality. Perhaps our need to plan outcomes and to base value judgements of success upon the physical implementation of these outcomes has become outdated. Perhaps it is time for a new way of thinking, a new way of planning, a new way of evaluating. Complexity theory indicates that we are already aware of the impossibilities of describing certain systems in a linear fashion. It also indicates that perhaps the best approach to complex systems "management" is to allow the system to grow, similar to our intuitive participatory and critical-rational planning approaches.

I hope to present further discussion about the following:

- 1) What is complexity theory?
- 2) Is complexity theory relevant or necessary for planning theory?
- 3) How can complexity theory be applied to planning?
- 4) What outcomes could result from complexity theory applied to planning?

Unfortunately this paper functions more as an appetizer than a main course, but hopefully it will evoke an interest to study complexity theory and its implications for planning further. I know it has for me.

What is complexity theory?

*"There must always be a discrepancy between concepts and reality,
because the former are static and discontinuous
while the latter is dynamic and flowing."*

-Robert M. Pirsig

In order to understand complexity theory, we must first look at how it has evolved. Complexity theory originated from chaos theory. In 1961 a meteorologist named Edward Lorenz officially discovered chaos theory. He was working on the problem of weather prediction. He had a computer set up, with a set of twelve equations to model the weather. It didn't predict the weather itself, however this computer program did theoretically predict what the weather might be.

One day, he wanted to see a particular sequence again. To save time, he started in the middle of the sequence, instead of the beginning. He entered the number off his printout and left to let it run. When he came back an hour later, the sequence had evolved differently. Instead of the same pattern as before, it diverged from the pattern, ending up wildly different from the original. Eventually he figured out what happened. The computer stored the numbers to six decimal places in its memory. To save paper, he only had it print out three decimal places. In the original sequence, the number was .506127, and he had only typed the first three digits, .506.

By all conventional ideas of the time, it should have worked. He should have gotten a sequence very close to the original sequence. Surely the fourth and fifth decimal places, impossible to measure using reasonable methods, can't have a huge effect on the outcome of the experiment. Lorenz proved this idea wrong. This effect came to be known as the butterfly effect. The amount of difference in the starting points of the two curves is so small that it is comparable to a butterfly flapping its wings.

The flapping of a single butterfly's wing today produces a tiny change in the state of the atmosphere. Over a period of time, what the atmosphere actually does diverges from what it would have done. So, in a month's time, a tornado that would have devastated the Indonesian coast doesn't happen. Or maybe one that wasn't going to happen, does. (Ian Stewart, Does God Play Dice? The Mathematics of Chaos, pg. 141)

This phenomenon, common to chaos theory, is also known as sensitive dependence on initial conditions. Just a small change in the initial conditions can drastically change the long-term behavior of a system. This discovery led Lorenz on to other aspects of what eventually came to be known as chaos theory.

The equations for this system also seemed to give rise to entirely random behavior. However, when he graphed it, a surprising thing happened. The output always stayed on a curve, a double spiral. There were only two kinds of order previously known: a steady state, in which the variables never change, and periodic behavior, in which the system goes

into a loop, repeating itself indefinitely. Lorenz's equations are definitely ordered - they always followed a spiral. They never settled down to a single point, but since they never repeated the same thing, they were not periodic either.

Complexity theory, which evolved out of chaos theory, is the study of complex, dynamic, nonlinear systems. Ralph Lewis, Director of Adept Consulting, defines complexity as that zone between stability and predictability, on one side, and chaos and unpredictability, on the other (see attached diagram). This is why the phrase, "the edge of chaos", is often used to describe complexity, although the edge of stability would apply equally well. In the complexity zone, systems adapt and learn and grow. In stability nothing changes. In chaos, too much changes for any learning to occur.

Sam Overman from the University of Colorado at Denver explained complexity in an imaginary model where "order and chaos are two sides of the same paper, with the image on each side bleeding through to the other every time we look at it." With this image I conceived the idea to generate a mobius strip combining chaos and order into a whole (see model). Although this model limits the number of possibilities by existing as it does, topology allows us to formulate an indefinite number of combinations where these seemingly contradictory concepts coexist in one plane. This concept bleeds into our every day understanding of who we are and how we relate to others as well. As complex beings we are capable of exhibiting multiple, unpredictable behaviors at any given moment as a result of this internal duality within our minds.

To further illustrate complexity, imagine a parking lot full of cars, with everyone trying to leave at once. The parking lot goes from a near equilibrium state to one of apparent chaos as everyone starts to simultaneously move towards the few exits. Glimpses of order emerge as lines gradually form and people self-organize. Occasionally this order breaks down and new line structures reform. The system is irreducible because even when you know that everyone is alternating entry into line, you can not predict the behavior of the very next car to enter a line. All over this parking lot, identical traffic patterns or fractals emerge and dissipate until the lot is finally empty, and the chaos moves elsewhere. During the process of rearrangement, complexity is at its highest, bouncing back and forth between chaos and order. It is at times like this that people are most apt to come up with creative solutions. For example, some people may choose to stay put and tailgate while others may opt for a taxi and still others may attempt to bribe or bully their fellow drivers. These variances are even further out of the realm of expected results and add to the level of complexity and diversity of self-organizing systems.

Complexity theory offers a new way of viewing the world. Instead of encouraging specialization, complexity theory encourages a broad view of the whole. As planners we would be wise to take advantage of such a valuable process.

Why should complexity theory be considered in relation to planning theory?

"A world of made is not a world of born."

-e.e.cummings

Complexity theory has been applied to such diverse fields as archaeology, economics, physics, sociology, biology, chemistry, and more. As a new theory it has been widely accepted and integrated into our scientific community. It is obvious that scientific thought and experiment have had a strong influence on theory and practice in disciplines outside of the physical sciences. Based on ideas of men like Newton and Maxwell or Darwin and Linnaeus, science developed and defined not just specific theories of gravity and electricity or evolution and classification, but large-scale ways of thinking upon which we base our inquiries in many other disciplines, including social, political, and administrative sciences.

It is amazing that so many scientists would have relied upon linear relationship studies as the sole method for analysis for so long. Differential calculus has been in existence since the 1700's. Physicists and mathematicians have been seeking answers about every material thing in the universe since the great Renaissance Age. In the last 300 years we have made more scientific discoveries than all the years of mans existence before. And with the advent of the computer, I am certain that more findings will result. The beauty of computers is that they enable us to seek connections between complex systems which otherwise might go overlooked. Although most of us have an intrinsic intuition that enables us to take in many variables and to assimilate our readings without the use of computers, we have come to rely heavily upon scientific method as our sole approach to truth.

During the last century, science itself has changed, and the new sciences challenge not just the assumptions of our older, established scientific theories, such as evolution and atomism, but also our logic and assumptions about the nature and reality of life. The new sciences now lead us to rethink and reformulate a new science of planning.

According to Lawrence P. Leach, principal of Quality and Systems Consulting, "This new science is one of synthesis; it brings together what humanity is learning in a wide variety of fields. It is a significant departure from the increasing specialization that has marked the scientific age." Since planning is such a comprehensive field incorporating so many disciplines into one, complexity theory readily applies itself. It is only a matter of time until more and more planners start to utilize this dynamic approach as part of their planning strategy.

How can complexity theory be applied?

*"The only constant in our business is that everything is changing.
We have to take advantage of change and not let it take advantage of us.
We have to be ahead of the game."*

-Michael Dell,
Dell Computer Corp.

Some would argue that we have already incorporated complexity theory into our planning process without even being aware of our actions. Participatory planning and critical-rational planning evolved on their own as a result of the people making their own place in the process. This act alone is one of a complex system and so lends itself to the theory of complexity far more adequately than to the more traditional theories of scientific method. We do not even know why or how these processes work because the tools we have been using to attempt to evaluate them are not adaptive enough to give adequate measures of success.

In the article, Consensus Building and Complex Adaptive Systems, by Judith Innes and David Booher, the authors state that consensus building and other forms of collaborative planning are increasingly used for dealing with social and political fragmentation, shared power, and conflicting values. The authors contend that to evaluate this emergent set of practices, a new framework is required modeled on a view of self-organizing, complex, adaptive systems rather than on a mechanical Newtonian world. They propose that consensus building processes be reviewed in light of complexity science and offer principles for evaluation and a set of process and outcome criteria.

By using complexity theory as a new framework for planning, entirely new processes are likely to develop. No longer limited by tangible outcome based analysis, we will be able to invest greater confidence in self-organization, and relax the constraints of prediction and control. The focus will not only be on tangible solutions but also on energy, not matter, on becoming, not being, on intentionality, not causality, and on constructing our reality, not waiting for it to be determined.

What outcomes can be expected from complexity theory application?

"The purpose of modeling is insight, not numbers."

-Hamming

One of the most significant outcomes of applied complexity theory is the realization that all that may emerge as a result of a few initial actions may not be readily apparent and may actually be much greater than initially observed or anticipated. Of course this outlook also allows for certain levels of negative results but by incorporating collaborative efforts into decision-making processes, the negative implications should be minimized.

Participatory and Critical-rational approaches offer solutions for complex issues. These approaches encourage social learning resulting in social, political, and intellectual capital for stakeholders. Over time changes in individuals may occur which influence other individuals. New partnerships may form. Perspectives, practices, and norms may change. The list of intangible outcomes is almost infinite. One small drop can have a large ripple effect. Maybe the initial push is enough to generate a self-organizing system capable of creating its own reality. Complexity theory enables us to place value on these intangible outcomes.

Theories are meant to provide structure for understanding. Complexity theory presents a new way of viewing outcomes and asks if we aren't limiting ourselves too much by expecting to be able to readily judge a process or action upon a fixed determinate. After all, most of the planning we do is influenced by people and as such lends itself to complexity. If we are constantly trying to plan for the future using static models as a means to do so, are we really ever going to achieve our end objective? Complexity theory allows for planning to evolve and encourages a self-organizing pattern to emerge. Idealistic to some but to others it's just a way of life. Haven't we been planning and self-organizing all along? All we are doing now is looking at our actions from a different more complex framework.

As more and more disciplines incorporate complexity theory into their practices, we are bound to learn even more about random systems. Hopefully in time we will be able to steer self-generating processes in a more efficient manner without losing the valuable variances that can result due to unpredictable inputs.

Conclusion

"It is a clear, though lamentably common, error to assume that the current utility of a feature permits an inference about the reasons for its evolutionary origin. Current utility and historical origin are different subjects. Any feature, regardless of how or why it first evolved, becomes available for co-option to other roles, often strikingly different."

-Stephen Gould

Complexity theory has already become a valuable part of our society. Whether or not we choose to integrate it into the planning community is mute. It will occur with or without our acknowledged consensus because of all of the disciplines embedded within our own which are already utilizing it. The theory offers a new way to view outcomes, initial moves, and systems as a whole. It is by no means complete but it is interesting and somewhat revolutionary with respect to scientific methods of the past.

As a complex being, complexity theory makes sense. Who would ever think that a person could be explained in a linear equation? Who would ever propose that a dynamic, nonlinear, deterministic system changing over time is readily explained in linear fashion?

Complexity theory implies that evolutionary processes occur whenever systems are pushed into or out of chaos or stability. By challenging past theories and by looking into complexity theory further we are participating in a new form of self-organizing. This theory will not be the last but perhaps it will have enough of an impact to allow for further exploration into how systems as a whole function in relation to one another.

Planning is ultimately about being able to make decisions based upon current insight in an attempt to generate a better or more accepted reality. By allowing participants to engage in this process throughout its entirety, and by not focusing on outcomes so much as on momentary insights, new self-organizing realities result. Looking back we will probably be able to see a complex pattern emerge and that in itself may be enough understanding for the new planners to embrace.

"Tradition, tradition..."

-Topol

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