The two perspectives of strategy process most firmly established in the literature—strategic choice and ecology—assume the same about system dynamics: negative feedback processes driving successful systems (individual organizations or populations of organizations) toward predictable equilibrium states of adaptation to the environment. This paper proposes a third perspective, that of complex adaptive systems. The framework is provided by the modern science of complexity: the study of nonlinear and network feedback systems, incorporating theories of chaos, artificial life, self-organization and emergent order. Here system dynamics are characterized by positive and negative feedback as systems coevolve far from equilibrium, in a self-organizing manner, toward unpredictable long-term outcomes.

**INTRODUCTION**

Chakravarthy and Doz (1992) identify the principal challenge facing strategy process research as follows: to address the 'central evolutionary and transformational processes' through which organizations renew themselves, rather than simply focusing on single administrative systems. There are two well-established perspectives from which this strategy process challenge is most frequently viewed.

The first is that of strategic choice—a transformational process in which organizations adapt to environmental changes by restructuring themselves in an intentional, rational manner (Zajac and Kraatz, 1993; Fombrun and Ginsberg, 1990; Zajac and Shortell, 1989; Ginsberg, 1988; Thompson and Tuden, 1959). The second is that of ecology—an evolutionary process of competitive selection in which whole populations of organizations adapt to environmental change, given that individual organizational adaptation is blocked by institutional inertia and resource specificity (Hannan and Freeman, 1977). Despite the significant differences in terms of predicted outcome, however, both clearly make the same assumptions about system dynamics, namely, that successful systems (individual organizations/whole populations) are driven by negative feedback processes toward predictable states of adaptation to the environment. The dynamics of success are therefore assumed to be a tendency toward equilibrium and thus stability, regularity and predictability.

These assumptions, which originate in Newtonian physics and Darwinian evolution (Parker and Stacey, 1994), are now being questioned at a fundamental level by developments in physics, biology, and mathematics. These developments can be grouped under the heading 'the science of complexity', a science which is concerned with the dynamical properties of nonlinear and network feedback systems (Gleick, 1987; Waldrop, 1992; Kauffman, 1991, 1992; Gell-
Mann, 1994). The study of these systems has revealed that in order to produce creative, innovative, continually changeable behavior, systems must operate far from equilibrium where they are driven by negative and positive feedback to paradoxical states of stability and instability, predictability and unpredictability. The transformational process is one of internal, spontaneous self-organization amongst the agents of a system, provoked by instabilities, and potentially leading to emergent order. The evolutionary process is one of competitive selection which weeds out all systems incapable of spontaneous changeability. The dynamics of success then have to do with being kept away from equilibrium adaptation in states of instability, irregularity and unpredictability.

This paper suggests that the revolutionary new science of complexity may provide a framework for a third perspective on strategy process—one that pulls together, into a coherent whole, literature covering a number of views which do not currently command all that much attention from those researching the strategy process. The nature of this third perspective will be clarified by comparing how it and two well-established perspectives mentioned above deal with the following three closely interrelated issues:

1. The issue of ‘systemic properties’ raised by the questions: what are the fundamental properties of human systems that make them capable of transformation and renewal? Or to put it another way: what are the evolutionary and transformational processes that make organizations ‘changeable’?

2. The ‘intention vs. emergence’ issue raised by the questions: are new organizational states the outcome of prior shared intentions of the agents operating within them? Or do such states emerge from complex interactions between agents in the absence of prior shared intention? In other words: is it possible to determine the long-term future outcomes of a changeable system?

3. The ‘free choice vs. determinism and constraint’ issue raised by the questions: are agents in a changeable system free to choose strategy and its outcomes? Or are their choices determined by the nature of their system and the environment it operates in?

**ESTABLISHED PERSPECTIVES ON THE THREE ISSUES**

**Systemic properties**

For the strategic choice school, the links between cause and effect are such that individual organizations can themselves choose to reach equilibrium adaptation—it is assumed that environmental changes are largely (but not totally) identifiable; that organizations purposively and intendedly adapt to these environmental changes through restructuring themselves; and that they do so in patterned, theoretically predictable ways (Zajac and Kraatz, 1993). This school also assumes that a strategy/environmental coalignment is desirable/needed and that organizations generally manage to secure such an alignment (Zajac and Kraatz, 1993). Translating this into the language to be used below to make comparisons, this means that organizations use negative feedback processes of formulating plans/policies and then implementing them using monitoring forms of control.

For the ecology school it is populations of organizations which adapt and the negative feedback process of competitive selection ensures that this happens: a particular environmental state is compatible with a limited number of particular states of the organizational population and deviations from those states are weeded out through competitive failure. The population of organizations is thus pulled toward an equilibrium state.

Clearly, both of these theories are assuming that organizations in their environments are systems in which there are clear-cut links between specific causes and specific effects. Negative feedback then ensures movement toward predictable equilibrium states, where the dynamics are those of stable, regular behavior. In both cases irregular behavior occurs because the environment bombards organizations with events that agents within them have not foreseen (random shocks) or cannot deal with. Any disorder is therefore the consequence of ignorance, inertia or incompetence. The matter at issue between the two perspectives is simply the extent of this ignorance, inertia, and incompetence—the strategic choice perspective claims that it is not sufficient to block individual organizational ability to restructure successfully and the ecology perspective holds the opposite view.
Intention vs. emergence

How each of the major perspectives deals with the issue of intention vs. emergence follows from the assumptions they make about the extent of ignorance, inertia and incompetence. From a strategic choice of perspective it is primarily the intention of the dominant coalition in an individual organization which determines whether it restructures or not, and whether that restructuring is successful or not—they are intendedly and bounded rational (Zajac and Kraatz, 1993). A population of organizations would then display patterns over time which are the aggregate of individual organizational intentions.

The ecology perspective, however, sees individual organizational outcomes as the product of an original intention as to institutional structure/resource endowment and subsequent competitive selection in the face of environmental change and organizational inertia. The long-term state of an individual organization thus emerges as far as the agents within it are concerned. But this emergent state is predictable—knowing the environmental change and knowing the institutional frameworks/resource endowments of the population of organizations, it is possible to predict who the survivors will be and what the population of organizations will be like.

Choice vs. determinism and constraint

From an ecology perspective, the evolution of an individual organization is fully determined by its initial institutional and resource choices, its inertia and the subsequent changes in its environment. According to strategic choice theory organizations are not so constrained by inertia, but success still requires that an organization be adapted to its environment—this implies some kind of deterministic relationship between the environment and the strategy/structure of an organization. Although environmental changes are assumed to be largely identifiable and unambiguous, choice remains a possibility because the environment–organization relationship allows for multiple equilibria—one cause has a limited number of potential effects from which it is assumed agents can choose (Zajac and Kraatz, 1993).

It can be seen from the above discussion that both the strategic choice and the ecology schools have in mind much the same kind of organization-in-its-environment system, with much the same dynamical properties, being driven by much the same kind of processes—they differ primarily in their views about organizational inertia and therefore in their prediction about individual organizational restructuring.

ALTERNATIVE VIEWPOINTS

There are a number of other viewpoints in the management, economics, and sociology literatures which make assumptions about system dynamics that differ fundamentally from those of the two established perspectives discussed above.

Contradiction, paradox and nonequilibrium

When paradox (Hyman, 1987; Hampden-Turner, 1990; Quinn and Cameron, 1988) becomes the central focus then organizations are viewed as nonequilibrium systems with dynamics that are essentially disorderly, developing through political processes (Pettigrew, 1973, 1977, 1985; Pfeffer, 1981) in a dialectical manner (Pascale, 1990) and displaying one crisis after another (Miller, 1990). The contradictory nature of organizations makes it impossible for managers to establish a shared intention about comprehensive long-term outcomes in which their organization is adapted to its environment. Those outcomes partly emerge as far as the agents are concerned and partly they are the result of intentional choice (Mintzberg and Waters, 1985).

Spontaneous self-organization and creative destruction

Here, organizations are assumed to be systems, in turn part of larger environmental systems, that evolve through a process of creative destruction (Schumpeter, 1934) and spontaneous self-organization (Hayek, 1948). Such evolving systems are so complex that agents within them cannot intend their long-term futures. Instead, those futures emerge unpredictably from the interactions between agents in conditions of nonequilibrium and disorder. Individual free choice plays a vital role in the unpredictable, creative evolution of the system.
Irregularity and disorder as a systemic property

In sociology, structuration models (Giddens, 1979) present organizations as continuous feedback systems in which behavior unfolds or emerges from a dialectical process. The regularities in behavior come about because each successive piece of behavior is conditioned by the institutions within which it occurs (Weick, 1969/1979; Schein, 1985; Johnson, 1987), but each time around the choices of individuals can also make a difference in the sense that they can change the institutions. Irregularity and disorder can occur because of the nature of the system itself—individuals are free to disrupt institutions. Human systems are driven by feedback loops in which both free choice and constraint are present and the state systems occupy is the result of their detailed histories. The circular feedback nature of choice, action, and outcome leads to a complex connection between cause and effect (Forrester, 1958, 1961; Senge, 1990).

Positive feedback

Vicious (or virtuous) circles are immediately obvious examples of positive feedback loops in organizations (Gouldner, 1964; Merton, 1957; Arthur, 1988). Systems dynamicists (Forrester, 1958; Hall, 1976; Senge, 1990) have demonstrated that nonlinearity and positive feedback loops are fundamental properties of organizational life and that behavior patterns can emerge without being intended and in fact often emerge contrary to intention, producing unexpected and counter intuitive outcomes. An example of this is Hall's (1976) study of the demise of the Saturday Evening Post. Hall showed how promotion expenditure taking the form of free trial subscriptions was having the intended effect of boosting sales volumes, but as the proportion of subscribers on free trials rose, average subscription rates plummeted with the unintended effect of cutting profits. When this was added to increased advertising rates leading to more than proportionate reductions in advertising volumes, the magazine was driven out of business. Apparently favorable policies in one area soon had amplifying adverse outcomes in other areas.

None of these alternative viewpoints commands anything like as much attention in the literature as the strategic choice or ecology perspectives, and this is even more true of management and consulting practice where the explicit emphasis is quite clearly on the strategic choice perspective. And each of the alternative viewpoints outlined above is based upon a fundamental assumption about organizational dynamics which is quite different from strategic choice/ecology perspectives. These differences are summarized in Table 1.

Two questions may be posed in relation to this comparison: is there any theoretical reason for putting the disparate viewpoints together into one coherent framework as an alternative to the two well-established perspectives? Is there any theoretical reason for adopting such an alternative perspective rather than the established ones?

This paper argues that the answer to these questions is 'yes.' The reason for this answer is that although they were developed largely independently of each other, the alternative viewpoints listed above all turn out to deal with one aspect or another of the dynamics of a particular class of systems—nonlinear and network feedback systems, the subject area of the modern science of complexity. That science of complexity provides the theoretical framework for combining the above alternative viewpoints into a coherent perspective of strategy process, one which is arguably more comprehensive than either of the well-established perspectives. What is this 'science of complexity?'

SOME INSIGHTS FROM THE SCIENCE OF COMPLEXITY

The science of complexity is concerned with the fundamental logical properties of the behavior of nonlinear and network feedback systems, no matter where they are found. To date, most of the work in this field has been carried out in relation to systems in nature (the development of this science is described in Gleick, 1987; Waldrop, 1992; also see Prigogine and Stengers, 1984; and Nicolis and Prigogine, 1989, for self-organization), but there is a growing interest in applying the discoveries to social systems (e.g., Anderson, Arrow and Pines, 1988; Nonaka, 1988; Peters, 1991; Wheatley, 1992; Zimmerman, 1992; Stacey, 1991, 1992, 1993; Goldstein, 1994).
Nonlinear feedback systems

First, why should organizational theorists pay attention to the science of complexity? The answer is that organizations are nonlinear, network feedback systems and it therefore follows logically that the fundamental properties of such systems should apply to organizations.

Organizations are clearly feedback systems because every time two humans interact with each other the actions of one person have consequences for the other, leading that other to react in ways that have consequences for the first, requiring in turn a response from the first and so on through time. In this way an action taken by a person in one period of time feeds back to determine, in part at least, the next action of that person. Feedback systems are what they are because of the history they have experienced and that statement certainly applies to people and groups of people.

Furthermore, the feedback loops that people set up when they interact with each other, when they form a network, are nonlinear. This is because: the choices of agents in human systems are based on perceptions which lead to nonproportional over- and under-reaction; there are almost always many outcomes possible for any action; group behavior is more than simply the sum of individual behaviors; outcomes are usually stubbornly individual and often peculiar; and without doubt small changes often escalate into major outcomes. These are all defining features of nonlinear as opposed to linear systems and, therefore, all human systems are nonlinear feedback networks.

Given this conclusion it is reasonable to expect that two fundamental dynamical properties which have been identified in relation to nonlinear feedback systems and network feedback systems (e.g., cellular automata and complex adaptive systems) in general should apply to organizations in some way. These properties are

1. bounded instability; and
2. spontaneous self-organization and emergent order.

BOUNDED INSTABILITY

Deterministic laws

All nonlinear feedback systems, including human organizations, can be expressed in terms of lawful rules and relationships: that is, such systems are deterministic in the same fundamental sense as Newton’s laws or the laws of supply and demand in neoclassical economic theory.

In organizations such laws take the forms of decision rules and scripted relationships between people within an organization and with people...
across organizational boundaries—the 'institutions' referred to above in the discussion on Giddens' analysis. Agents in such a system have no choice but to move around the nonlinear feedback loops which these 'institutions' constitute and in that sense the system in which the agents operate is deterministic. Each time an agent goes around this loop, however, that agent is free to vary, ignore or alter the institutional arrangements—agents follow decision rules and behavioral scripts but those rules and scripts allow freedom of choice. So, agents can change the rules, schemas or scripts which govern their behavior, but they cannot remove the nonlinear feedback nature of their interactions, nor can they remove the consequence of that nonlinear feedback.

... may lead to stable outcomes

The outcome of any individual free choice, however, is determined not only by that agent's chosen intervention but also by the chosen interventions of other agents. When all the agents involved in the system accept a given set of rules and make their choices in accordance with those rules, then the whole system will eventually settle down into a state of regular behavior, that is, stable equilibrium. In other words, the system operates in a negative feedback manner to sustain regular predictable behavior—it is attracted to stable equilibrium adaptation to its environment when the rules are appropriate.

... or to unstable outcomes

On the other hand, if all the agents involved in a system keep changing the rules governing their behavior then no one will be able to rely on others. The system is then driven by amplifying, positive feedback along a predictable, explosively unstable equilibrium path—the system is attracted to unstable equilibrium. So, as the contention level in a human system is raised, that system passes from a state in which it is attracted to stable equilibrium behavior to a state in which it is attracted to unstable behavior. The same kind of phenomenon applies to all nonlinear feedback systems wherever they are found, in nature or in mathematics—as some parameter (reflecting the speed with which energy or information moves through the system) is increased they pass from states of stable equilibrium to some explosively unstable state.

In the cases far discussed a determinsitic system leads to predictable, that is, determined outcomes. The profound insight coming from the science of complexity is that nonlinear feedback networks also have available to them a third state of behavior, a state which is neither stable nor unstable, but both at the same time.

... or to indeterminate outcomes: bounded instability

When a nonlinear feedback operates in a state poised at the edge of instability its behavior is paradoxically both stable and unstable at the same time: there is instability in the sense that specific behavior is inherently unpredictable over the long term, but there is also stability in the sense that there is qualitative structure to that behavior and also short-term outcomes are predictable. For example, the weather is unpredictable in specific terms over the long term, but we can say something about the next few days and the weather does display recognizable qualitative patterns of storm and sunshine. Or, to take an organizational example, we can detect archetypal, irregular patterns of fight, flight, and dependency behavior in groups of people when anxiety levels rise, but we cannot predict the specific course which those patterns will follow over any given time period.

Behavior at the edge of instability (or you could say the edge of stability) follows a random, inherently unpredictable path over time, but it does so within given limits—it is boundedly unstable. This behavior has been given names such as chaos; strange or fractal attractors; edge of chaos. For the purposes of this paper all of these terms are lumped together despite the fact that there are differences in their precise meanings. One of the key points as far as this paper is concerned is that all of these terms describe specific behavior that is inherently unpredictable over the long term but nevertheless has a recognizable pattern or structure. For most of the remainder of this paper the term bounded instability will be used to describe such behavior in the belief that it is the conceptual or philosophic content rather than the mathematical precision which is key to management and organizational theorizing. Another key point for the purposes
of this paper is that it is both simple and complicated, both deterministic and probabilistic nonlinear feedback networks that can generate long-term outcomes which are indeterminate, that is, boundedly unstable.

The reason for this ‘strange’ behavior is that the system utilizes both positive and negative feedback, flipping autonomously from one to the other, rather than either negative feedback which can produce stability or positive feedback which produces instability. This state makes it possible for tiny changes—so tiny that it would be impossible to detect or measure them, to escalate into major qualitative alterations in the behavior of the system. This ‘sensitive dependency on initial conditions’ means that, for all practical purposes, links between specific causes and specific effects, between specific actions and specific outcomes, are lost in the complexity of what happens.

Prior shared intention?

When a nonlinear feedback system operates at the edge of instability, therefore, agents in that system cannot intend the long-term outcomes of their actions. Instead, those long-term outcomes emerge from the detailed interactions between the agents. Furthermore, new patterns of behavior that emerge fall within recognizable categories—they are similar to but never the same as previous patterns of behavior. In this sense history repeats itself but things are never the same. Although individual agents operate in a deterministic system (or a probabilistic one), they can quite easily exercise real choices that could have major impacts: they simply cannot know in advance whether a major impact will emerge and if so what it will be and hence they cannot intend the long-term outcomes of their next chosen actions. Choice is not restricted to a limited number of predictable equilibria—choice is truly open ended with unknowable outcomes.

Review of the argument so far

To summarize, perfectly deterministic nonlinear feedback networks may be attracted to one of a number of states.

When such systems are attracted to stable equilibrium, then there are clear-cut connections between cause and effect, so that conditions in the environment determine through the feedback laws what the long-term outcome is to be if the system is to be adapted—and it is perfectly possible for there to be a limited number of such adapted outcomes, as the strategic choice school assumes, because this is a nonlinear system. Individual agents could, therefore, make a difference by choosing one of these adapted equilibrium outcomes rather than another—they could intend the outcome of their actions but the range of such actions and outcomes are in effect prescribed within given limits by the environment if the system is to be adapted to its environment. The ecology school sees the same system dynamics but assumes that internal inertia prevents agents from implementing any choice they may make.

The two well-established perspectives therefore enable us to understand the development of organizations when they operate in stable equilibrium, where they can change in predictable ways, either repeating past behavior or selecting from a limited range of behaviors with foreseeable outcomes. In these circumstances, agents have to shift their system from one equilibrium position to another, selected from a limited number of feasible equilibria, and shifting from one equilibrium to another is difficult—the inertia forces operating on the system try to keep it in its existing equilibrium. This shift to a new, predictable equilibrium state is not the same as true innovation and creativity because that which is truly new is not already in the past or the present and cannot therefore be predicted. Creativity is rather associated with that endless variety of behavior arising from spontaneity.

It is at the edge, in bounded instability, that deterministic nonlinear systems become internally and spontaneously changeable—their behavior displays endless unpredictable variety in the sense that no behavior pattern is ever repeated exactly. When a system is in this state agents are constrained by their decision rules and behavioral scripts, but the choices they make within those constraints can have major consequences for the system because small changes can escalate into major qualitative changes in outcomes. When it is at the edge of instability, a system is far easier to change because small actions of agents within the system can escalate into major outcomes. Those outcomes, however,
are not determinate: instead they emerge in the sense that they are surprising results, not of given environmental conditions, but of the undirected, self-organizing interactions between agents within and across system boundaries, who are together creating and recreating their environment. In other words, we have deterministic laws that lead to unpredictable, emergent outcomes. Disorder is not simply the result of inertia, incompetence or ignorance—it is a fundamental property of creative systems and it plays a vital role in that creativity. (A probabilistic feedback network, that is, one into which random shocks are introduced, has the same fundamental properties.)

This is not the kind of world that can be explained by either of the well-established perspectives of the strategy process. But it does seem to be very much the kind of world which each of the alternative viewpoints outlined above has in mind. The state of bounded instability that nonlinear feedback systems operating at the edge of stability are capable of generating quite clearly encompasses notions of inherent contradiction, feedback loops with a combination of free choice and constraint in which individuals can make a major difference, the operation of positive feedback, the idea of emergence and nonequilibrium concepts. All of these ideas can be brought together within a nonlinear feedback framework to construct a model of organizational dynamics. Furthermore, the concept of boundedly unstable behavior can be used to identify, in a more comprehensive way, the consequences of the notions of paradox, circular feedback loops, positive feedback processes and emergence.

**Bounded instability and organizational dynamics**

A nonlinear feedback framework for thinking about the strategy process would focus on the states to which an organization might be attracted: stability with either single or multiple equilibria; instability; or some state at the edge of instability. That latter state has been named bounded instability by some, chaos or the edge of chaos by others, and fractal or strange by yet others. There are differences in the precise meaning of all these terms but what they all share in common is that they describe a complex state of behavior which is both stable and unstable at the same time, in which connections between cause and effect disappear for practical purposes and in which therefore specific outcomes are unpredictable. What does all this mean in organizational terms?

All organizations consist of formal and informal systems and when we consider the stability and instability conditions of an organization’s dynamics we need to distinguish between these two systems.

**... stable equilibrium and the forces of integration**

The formal system of an organization exists in the first place to carry out existing, repetitive, day-to-day activities as efficiently as possible and it must therefore function according to well-defined hierarchical structures and strictly applied rules and procedures. By its very nature an efficient formal system in an organization is not changeable—it is meant to resist change and sustain the status quo in the interests of efficiency. The formal organization of any successful organization, innovative or otherwise, will therefore be orderly and stable. It is the powerful forces of integration, maintenance controls, as well as the need to adapt to the environment which pull the whole formal system of an organization toward stable equilibrium (Lawrence and Lorsch, 1967). Where this pull is reinforced by the informal system—a culture primarily satisfying the human desire for security, certainty, and conformity—then an organization as a whole will be attracted to stability. Negative feedback controls in both formal and informal systems will in effect generate behavior which is regular and predictable.

There is ample evidence of the existence and power of this attractor for organizational behavior. In the absence of strenuous effort to the contrary, organizations seem quite ready to slip into a stable bureaucratic state in which they carry on doing the same thing—the very point emphasized by the ecology school and well demonstrated in the studies by Pascale (1990) and Miller (1990).

**... instability and the forces of division**

At the same time as being pulled to stability, however, all organizations are also powerfully pulled in the opposite direction by the forces of division and decentralization (Lawrence and
examples of ‘chaos’ take the form of conflict, as when an organization experiences the clash of countercultures, the tensions of political activity, the contention and dialogue through which managers handle ambiguous strategic issues (Nonaka, 1988). There is ‘chaos’ when managers work in informal groups to learn and develop new strategies—the tensions they generate through the way they interact and exercise their power produce patterns of behavior that fall into recognizable categories, but are always different in specific terms.

Stability, instability or bounded instability?

As with all other nonlinear feedback systems, human organizations have open to them, in very broad terms, three alternative states of behavior: stability, instability, or bounded instability. The properties of these states in organizations are summarized in Table 3. Which leads to success? The answer depends upon the primary task.

‘Sticking to the knitting’

Organizations exist because stakeholders want them to perform some primary task. That primary task may be about preserving traditions and beliefs, or providing safety and security from anxiety. In that case an organization operating in some stable equilibrium state is probably best able to perform the primary task. If the primary task of a commercial enterprise were to be that of doing better what it already does well, building on its existing strengths and ‘sticking to the knitting,’ then a stable equilibrium state is probably the one required for successful operation. For these purposes the two well-established perspectives of strategic choice and adaptation through competitive selection provide adequate frameworks for understanding the strategy process.

Innovation

However, where the primary task is that of generating new products and services, continually renewing and transforming, then both the stable equilibrium and the unstable equilibrium states are death. In both of these states, systems change repetitively, or they change from time to time in predictable ways, but they are not inherently changeable or continuously innovative. Such
Table 2. Assumptions on system dynamics: Established perspectives compared to the alternative

<table>
<thead>
<tr>
<th>Established perspectives</th>
<th>Alternative perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause-and-effect links can be identified so that actions can be selected according to long-term outcome. Inertia may or may not block implementation</td>
<td>Cause-and-effect links disappear so that actions cannot be selected according to long-term outcome</td>
</tr>
<tr>
<td>Organizations seek or are selected for adapted equilibrium</td>
<td>Agents within organizations sustain far-from-equilibrium conditions of conflict, ambiguity and dialog</td>
</tr>
<tr>
<td>Long-term outcomes are either intended by dominant coalitions within organizations or determined by competitive selection</td>
<td>Long-term outcomes emerge out of both spontaneous self-organization and competitive selection</td>
</tr>
<tr>
<td>Behavior driven by negative feedback</td>
<td>Behavior driven by both negative and positive feedback</td>
</tr>
</tbody>
</table>

Table 3. The three attractors for organizations

<table>
<thead>
<tr>
<th>Stable equilibrium</th>
<th>Formal system</th>
<th>Informal system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated hierarchy and bureaucracy. Negative feedback control systems</td>
<td>Conformist, risk-averse dependent culture. Strongly shared vision and culture</td>
<td></td>
</tr>
<tr>
<td>(Functioning formal systems supported by informal systems)</td>
<td>Too decentralized ineffective control systems</td>
<td>High cultural diversity, conflict, widespread political activity</td>
</tr>
<tr>
<td>(Malfunctioning formal systems aggravated by subversive informal systems)</td>
<td>Integrated hierarchy and bureaucracy. Negative feedback control systems</td>
<td>High cultural diversity, conflict, widespread political activity, dialog. Weakly shared vision ambiguity, learning</td>
</tr>
<tr>
<td>Bounded instability edge</td>
<td>(Functioning formal systems subverted and so changed by informal systems)</td>
<td></td>
</tr>
</tbody>
</table>

organizations cannot be producing anything truly new because that which is truly new is by definition not in the past or the present and so is unpredictable. To be internally and spontaneously changeable and innovative a nonlinear feedback system has to operate in ‘chaos’, at the edge of instability (Stacey, 1911).

When stakeholders demand the new, only those organizations which are internally and spontaneously changeable—those operating at the edge—will survive selection by competition. The well-established perspectives apply when systems are not required to be innovative—then strategic choice may determine outcomes unless the organization is trapped by inertia, in which case it will be weeded out by competitive selection. However, when the requirement is for innovative organizations the strategic choice relates not to specific outcomes but to the kind of organizational dynamic—it has to be a choice to operate at the edge where long-term outcomes are unknowable. Competition then selects out both those that end up with an inappropriate specific outcome and those who have chosen not to operate at the edge.

Sustaining organizations at the edge of instability is far more difficult than giving in to the pull to either stability or instability. In these circumstances we would expect to find a population of organizations consisting of some which are stable in response to a stable primary task, successfully choosing their strategic outcomes; some choosing to operate at the edge of instability in response to a primary task to innovate, with
some of these succeeding and others being weeded out by competitive selection; and yet others choosing to operate as stable systems despite a primary task of innovation and therefore gradually, or radidly, being weeded out by competitive selection; and some succumbing to highly unstable disintegrating forces.

In such a population we will find organizational evidence for almost any specific hypothesis about the strategy process and organizational success, but we will only be able to make sense of it all by trying to understand the dynamics of whole systems.

The third perspective

A ‘complex system’ perspective is concerned with the dynamics of whole systems. At the individual organizational level it focuses the search for central evolutionary and transformational processes in the informal networks of organizations and the unstable, disorderly dynamics they generate. The application of the science of complexity to organizational life leads to the proposition that changeable organizations are those in which the informal feedback networks are sustained away from equilibrium in a state of bounded instability. The disorderly dynamics of contradiction, conflict, tension, and dialog provide the driving force for changeability.

Informal networks are generally established in rather random ways (Festinger, Schachter, and Back, 1950) depending on chance encounters and social proximity. Networks generally form around issues, and whether individuals are activated to join in a network around an issue often depends on chance. It is not so difficult to see how randomly formed informal networks, characterized by disorderly dynamics, might make an organization changeable in the sense of producing great variety in behavior patterns. But is there any reason to believe that this ‘chaos’ might produce coherent and useful patterns of behavior? The science of complexity has some insights that may well be of great use here.

SPONTANEOUS SELF-ORGANIZATION AND EMERGENT ORDER

Network feedback systems

Another way to conceive of a feedback system is in terms of a Boolean network (Kauffman, 1991, 1992). A Boolean network consists of a number of elements or cells. Each cell is connected to others, receiving inputs from some or all of those others and sending outputs to all or some of those others. What state each cell is in at any one moment—that is, what it is doing or outputting at any one time—depends upon the inputs it is receiving and the rules it follows to respond to those inputs. In other words the state of an individual cell changes from moment to moment according to the information or energy it receives and the rules it follows for converting these to action or outputs.

An example of a Boolean network

We can identify some fundamental properties of such a network by considering the following simple example. Suppose the network consists of a number of colored light-bulbs each of which can be switched either on or off. Suppose each bulb is assigned a rule which tells it whether it should be switched on or off. For example, one bulb may follow the rule that it will switch on if all the other bulbs to which it is connected are switched on. Or the rule could be that it will switch on as soon as two of those bulbs it is connected to are switched on. The bulb’s response is thus determined by the inputs it receives according to a fixed ‘decision-making’ rule.

Suppose that each cell in the network is randomly connected to others and randomly assigned a different decision-making rule. Suppose also that we start off by randomly assigning on and off positions. We then sit back and watch how the behavior of the system—the pattern of light—unfolds. At each instant each bulb will examine the information on the state of the bulbs linked to it, and applying its decision-making rules to that information the bulb will switch on or off. As it does this it will of course affect the state of some other bulb, and that in turn will trigger a change in another, until eventually the consequences feed back to affect the first bulb. In this way the whole network of bulbs changes state at each moment in time and the behavior it displays will depend upon the way in which the bulbs are interconnected—the way in which the network is wired up.
Attraction to instability: Randomness

When every element is wired up to every other then the whole system behaves randomly, never repeating a given pattern of on/off. Any tiny change in the initial pattern from which the system is started will lead to completely different subsequent patterns over time. It is hardly surprising, perhaps, that a system in which each element is connected to all others, each following randomly selected rules, should behave in a completely random way.

Attraction to stability: Emergent order

However, when each bulb is connected to only two others and random switching rules are allocated to all the bulbs, the whole system soon settles down into a fixed orderly state in which there are stable patches of light.

The important point, then, is that random local rules of behavior can result in emergent order at a global level, and whether there is order or not depends upon the degree of connectedness between elements of the network. When the order emerges, it is a surprise, because there is nothing in all the random individual decision rules which determines it. Instead, the emergent patterns are a property of the system, of the interactions rather than the individuals.

Again, we have seen a feedback system which is attracted to stability when it is configured in one way and to random instability when it is configured in another. When the interconnections between the elements in a network are sparse, then orderly, stable global behavior emerges from random local interactions and the system remains stuck in that behavior. As a richer pattern of interconnection is established the system becomes more changeable until, when everything is connected to everything else the system becomes random, with patterns of behavior changing so fast that we can make little sense of them. Analysis of cellular automata—a system of cells interconnected by arbitrary decision rules in much the same way as Boolean networks—has also shown that these systems produce a simple stable behavior when connectivity is sparse and random patterns when connectivity is very rich.

At the edge: Endless variety

However, just before such systems go completely random, at the edge of chaos, we find another form of behavior: coherent structures that grow, split apart, and recombine in different patterns in a never-ending way (Wolfram, 1986). What form these emergent patterns will take is unpredictable—the only way to find out is to run the system.

The work on Boolean networks and cellular automata has demonstrated that network systems consisting of random feedback connections at a local level can spontaneously produce emergent global order. When linkages are sparse that order will take a frozen unchangeable form. However, when a rich pattern of interconnections is established the system becomes changeable, with new forms continually emerging. If the interconnections become too rich, however, the system becomes so hyperactive that it becomes difficult to make any sense of it.

Feedback networks in organizations

This concept of a network connecting individual elements is of course already widely used in the management literature (Nohria and Eccles, 1992). The formal reporting structure of an organization is one kind of network in which the connections between one individual and another are centrally established, fixed, and clearly defined—there is nothing random about the interconnections between one person and another in formal organizational structures.

In the informal organization, however, we encounter what is to all intents and purposes a Boolean network. Each individual in an informal organization is linked to a number of other individuals both within his or her own organization and with individuals in others. These links are random in the sense that they come about through what largely amount to chance social encounters (Festinger et al., 1950). When an individual is ‘switched on’ by some issue, that individual links up with others in his or her network, potentially ‘switching them on’ too. Some later issue may prompt the same individual to activate a different part of his or her network, and which part is activated may depend significantly on chance encounters (Mueller, 1986).
What the analysis of Boolean networks and cellular automata has shown is that such a process of random connections in a network can produce different forms of order—different patterns of behavior—depending upon the extent of connectivity across the network. Thus we would expect to find that stable organizations are those in which there are relatively few informal connections between people within and across organizational boundaries. But where an organization has an informal system in which there are rich, random patterns of connection in this informal network we would expect to find that such an organization produces great variety in behavior—it will be changeable. And that changeability will be directly related to how close behavior patterns are to chaotic ones. Limited random connectivity across a network produces emergent order that remains stable for lengthy periods but rich patterns of random connectivity produce a changing variety of emergent patterns.

**Connectivity in Networks**

These findings on the relationship between the number of connections between the cells of a network and the changeability of the behavior which that network produces can be related to the research into strong and weak ties in the network systems of organizations. Granovetter (1973) demonstrated that organizations produced greater variety in behavior when the informal ties between people are weak rather than strong. Strong ties exist when people spend much time together, are emotionally involved, mutually confiding and provide reciprocal services. The effect of strong ties is to bind people together, making it likely that behavior will be repetitive and uniform. Weak ties, however, provide ‘bridges’ to other parts of a social system through which variety may be imported into a cluster of people held together by strong ties. Krackhardt (1992), however, argues that strong effective ties increase feelings of security and can thus make a group of people more likely to change: strong ties might then be associated with more variety in behavior than weak ties.

The analysis of Boolean networks suggests that it is the number of random ties rather than their individual strength or weakness that determines the variety in the behavior of a system. In Boolean network terms, a strong tie means that when cell or ‘bulb’ x turns on then so will y and vice versa; and a weak tie would be something along these lines: cell x turns on if w, y and z all also turn on, and y turns on only if z, m and u turn on. From this we can see that where the number of ties or connections is small, they are likely to be predominantly of the strong type, and where the number of connections is large the tendency will be for them to be of the weak type. Large numbers of ties imply weak ties and this means that the analysis of Boolean networks produces conclusions consistent with Granovetter’s findings. The point, however, is that a large number of randomly distributed ties will include both the strong and the weak and it is the number and the randomness that are important rather than the strength or the weakness itself.

**Implications for the strategy process: Self-organization**

Nonlinear dynamics and the analysis of Boolean networks and cellular automata suggest an alternative perspective for the strategy process: one that focuses on the informal feedback networks to be found in every organization in which individuals randomly establish linkages among themselves. The possibility of emergent order is a fundamental property of such feedback networks and changeability is also a fundamental property when the pattern of connectivity is rich enough. From this perspective the central evolutionary and transformational processes in organizations are ones of spontaneous self-organization, close to Hayek’s notion (1948), which make an organization changeable and produce emergent new patterns of behavior in the manner postulated by Giddens, Hayek, Schumpeter, and others.

The science of complexity leads to another proposition about changeable organizations: changeability becomes an internal property of an organization when its informal network system, consisting of self-organizing patterns of connections between people within and across its boundaries, is richly connected enough to operate on the edge of instability, where it produces ever-changing emergent patterns of behavior.
DISCUSSION AND CONCLUSIONS

The established perspectives on the strategy process assume that it is possible to identify connections between specific causes and specific effects, specific actions and specific outcomes. This makes it legitimate to think about a human organization as a system in which some outsider (the consultant) or privileged insider (the leader) is able to make choices about the future direction and destination of the organization and then require others to follow a master plan. This is possible because the existence of cause and effect links means that the future is in the present and can be extracted by analysis or intuition.

The science of complexity demonstrates that for a system to be innovative, creative, and changeable it must be driven far from equilibrium where it can make use of disorder, irregularity, and difference as essential elements in the process of change. But far from equilibrium the links between cause and effect disappear because positive feedback enables a system to escalate many tiny changes into globally different behavior patterns. Sensitivity to initial conditions destroys identifiable links between individual actions and global outcomes. The state a system is in now is the result of every detail of its history, and what it will become can only be known if one knows every detail of its future development, and the only way one can do that is to let the development occur. The future of such a system is open and hence unknowable until it occurs.

It follows quite clearly that no expert outsider and no privileged insider can know what the destination or direction will be until it occurs. Thus no one can be in control. Individuals and groups of individuals in an organization can choose, plan, and control their next intervention but they cannot choose, plan, or control the long-term outcome of that intervention. Instead, long-term outcomes emerge from a process which is basically self-organizing. The only alternative is to allow an organization to give in to the powerful pull to equilibrium where all will be predictable—but that ultimately means death because significant change is so difficult. Competition—the selection of the fittest—weeds out all organizations that are allowed to move away from the edge of instability.

The science of complexity also provides a framework for bringing together into an alternative perspective a number of disparate ideas (paradox, circular causality, positive feedback, creative destruction, spontaneous self-organization, emergence) that are to be found outside the most well-established perspectives of the strategy processes. From this third perspective we deal with the three issues identified at the beginning of this paper in ways that are completely different from the well-established perspectives:

1. As far as 'systemic properties' are concerned, the alternative perspective focuses not on equilibrium but on a far-from-equilibrium paradox where the dynamics are both stable and unstable at the same time. This chaotic behavior is located in those informal networks which people spontaneously and randomly establish amongst themselves in a self-organizing manner and is activated when the pattern of connectivity is rich enough. Such informal networks may be engines of enquiry—the organizational instrument for exploring the space of possibilities.

2. As far as 'choice vs. determinism and constraint' is concerned, the alternative perspective focuses on the possibility of open-ended choices available to agents made possible by chaotic dynamics, but constrained by the feedback structure of the system. Choice is possible not because there are a limited number of predictable equilibria, but because even though the system may be deterministic with regard to structure, it is open-ended with regard to outcome. Constraints do come from the tendency to inertia but this is not inevitable: the really important constraints are the self-organizing feedback structures people establish amongst themselves.

3. As far as the 'intention vs. emergence' issue is concerned, the alternative perspective focuses on processes of evolution and transformation taking the form of self-organizing network activities provoked by disorder, conflict, and disagreement. These processes produce emergent rather than intentional outcomes.

Implications for the research agenda

These conclusions form the basis for a somewhat different research agenda in the field of strategy process. Traditionally, the research questions
posed are conditioned by the notion that strategic management should reduce the level of uncertainty, so diminishing the element of surprise in the development of an organization. The complexity theory framework, however, poses a different question: how do/should managers conduct themselves in the presence of irremovable, indeed desirable, uncertainty, surprise, unknowability, and open-endedness?

More specifically, the complexity theory framework puts long-term planning and strategic analysis into context. Analytical thinking and planning processes can only apply to repetitive, predictable activities since the ability to analyze and plan rests firmly on the existence of causal connections and predictability. Analysis and planning are processes required to build on existing strengths and do more efficiently what is already done well; that is, to repeat the past more and more efficiently. Essentially the same conclusion must apply to the notion of ‘a shared vision’ when that notion refers to some consensual picture of a future state—in changeable systems it is not possible to specify meaningful pictures of a future state, and any pictures which are specified cannot be connected back to the actions required to realize them because cause-and-effect links disappear. Furthermore, consensus around some picture of a future state removes the chaos which changeable systems must experience if they are to innovate. This leads to two questions: if they cannot plan and envision the future, what do managers actually do when they innovate, when they face the unknowable? Why do managers continue to prepare long-term plans and talk about shared visions in response to the need to innovate when these are not appropriate responses?

Self-organization and innovation

First, consider what managers actually do when they innovate. The processes required for creativity are those of intuition and reasoning by analogy, and the new insights these processes lead to are amplified through an organization when managers operate in informal networks to promote significant change. When they innovate managers rely on self-organizing political and learning processes to produce an emerging, unfolding but unpredictable future. This can only happen when the informal networks are in a state of ‘chaos,’ that is, tension and conflict which generate dialogue. In such situations individuals and groups may learn and they may make a difference because tiny actions they take could escalate up through the system into major organizational changes—it is the positive feedback aspect of chaos that makes it possible for individuals to make a difference. There is no guarantee that this will happen, however, and the price is that the consequences of any individual intervention are unpredictable, indeed unknowable. Consequently new strategic direction, renewal, transformation, and innovation can only emerge. They must be negotiated in real time and cannot be arranged in advance.

The focus of research needs to be shifted firmly towards understanding the group dynamics of those spontaneously self-organizing political and organizational learning processes through which organizations innovate. The science of complexity suggests a focus on how random connections between people and the simple decision rules they use can lead to complex global patterns of behavior taking the form of new strategic direction and organizational renewal. Research work currently being done on networks and learning organizations is thereby put at the center of strategy process research. This research work should pay explicit attention to the positive role played by disorderly dynamics.

Defense against anxiety

Next, consider why managers continue to use planning processes. Planning and analysis are the processes of efficiency—they are required if an organization is to be able to carry out its repetitive day-to-day tasks. It follows that effective management is a paradox—managers must operate in a hierarchy using formal planning systems and analytical processes to conduct their business efficiently, but they must also operate in an informal network that seeks to undermine those hierarchies and systems in the interests of creativity and changeability. Understanding how this is done is a research program of great importance to strategic management.

But there is more to the use of planning processes and analytical techniques. It is clear that they are employed in circumstances in which a moment’s reflection shows them to be inappropriate—they are processes which have
for a long time been shown to be inapplicable to conditions of great uncertainty and yet they are used in just such circumstances. This suggests that managers use such routines and procedures to defend themselves against the anxiety which great uncertainty provokes; the literature on psychoanalytical approaches to organizations (Menzies, 1975; Jacques, 1955; Kets de Vries and Miller, 1984; Kets de Vries, 1980; Hirschhorn, 1990) therefore needs to be incorporated into strategic management thinking and the posing of research questions.

Leadership

The above conclusions have very important implications for the nature of leadership. Much of the research on leadership focuses on that type appropriate to conditions in which the leader can form some idea of where an organization is heading. But what does leadership mean when powerful figures in an organization may be able to choose, plan, and control the next interventions of large numbers of others but cannot choose, plan, or intend the long-term outcomes of those interventions? Research is required to understand more clearly how leaders affect and are affected by the informal networks of which they are a part, and what they need to do to encourage those networks to function in a manner which promotes conflict and dialog within boundaries.

To understand the kind of leadership required in turbulent times we need to understand more about the nature of the boundaries around the conflict, which is essential to organizational learning and how leaders may be able to manage those boundaries more effectively. More attention also needs to be paid to the notion of leadership which is located not simply in one person but shifts from person to person according to task needs or the emotional states of groups of people operating in informal networks (Bion, 1961). The causes and results of neurotic forms of leadership become particularly important here.

The complexity theory framework also has implications for the balance between strategy content and strategy process research. If futures are unknowable then it is impossible to select content areas that will be relevant for more than a rather short time period. The really fundamental questions and long-lasting ‘answers’ will relate to process.

Finally, the complexity perspective poses this question: how useful is the distinction between the tactical and the strategic in a world in which undetectable tiny actions can escalate into major outcomes, making it impossible to say in advance whether an action is tactical or strategic?

Implications for research methodology

The dominant frame of reference for research in management and organization is the reductionist one of testing hypothesized connections between a specific cause, usually in the environment, and a specific effect, usually in a part of the organization being studied. It is most usual to test these hypotheses using cross-sectional data on organizations obtained from statistics, public reports, questionnaires, and interviews.

The practical difficulties of this approach are of course well understood. First, the evidence and data collected to test hypotheses are based on what people in organizations say they do. It is now widely accepted, however, that behavior in organizations is driven by theories-in-use which often differ dramatically from espoused theories (Argyris and Schon, 1978)—people frequently say one thing and do another. It is also clear that behavior in organizations is determined to a significant extent by culture; that is, shared assumptions below the level of awareness on what to think and do and how to think and do it (Schein, 1985). The findings of cognitive psychology on how people make sense of the world by using partial mental models make it clear that managers use recipes, or causal maps, that they are usually unaware of (Johnson, 1987). The importance of tacit knowledge in the conduct of management has been established (Nonaka, 1991). This growing emphasis on what is tacit, below the level of awareness and contradictory, makes it unlikely that the straightforward application of questionnaire, public report, and interview data to the testing of hypotheses can be all that reliable.

In addition to these practical difficulties, there are also matters of principle. The reductionist approach of testing hypotheses about causality independently of each other assumes that the systems being studied are linear, or can be approximated by linear systems, or are nonlinear but are required to operate in states of stable equilibrium. From a complexity perspective,
however, organizations are essentially nonlinear systems which cannot be approximated by any linear form and to be creative they have to operate far from equilibrium. For such systems it is extremely difficult to find the specific causes of specific effects. Even where it is possible to do so with hindsight that provides little useful information about the future.

If innovative organizations are nonlinear feedback systems operating far from equilibrium then reductionist approaches to researching them are likely to produce seriously misleading conclusions. Cross-sectional tests of linear causal hypothesis will simply be interesting exercises in hindsight. Instead, research will have to focus on the meanings of the irregular patterns of behavior observed and on reasoning about the kind of system those patterns are being generated by. Instead of looking for causes and effects it is necessary to look for patterns and their systemic implications.

The specific methods appropriate for this kind of research do exist but are relatively rarely applied to strategy process research—longitudinal studies, action science, the ethnographic approach, and clinical methods. Action science and ethnography are well known but some further clarification of the clinical method may be in order. Hirschhorn (1990) describes the clinical method as one which uses incidents, transcripts, and the researcher's own feelings to interpret events and assess both manifest and latent meanings. The goal is to find a common thread of meaning in a person's or a group's particular action and experience.

To summarize, in the dominant approach to management research we establish a theoretical causal hypothesis and then, adopting the role of uninvolved experimenter, we gather data to test the hypothesis—we formulate a general theoretical model and then seek to apply it directly to particular experience. In the alternative ethnographic and clinical approaches the researcher, having been educated both by acquiring theoretical models and by the experience of previous interventions in social systems, approaches a particular new experience without a specific model in mind—general theoretical models are abandoned as far as possible in the attempt to identify meaning in the new experience.

The method is one of gathering data from free-floating discussions and informal interpretation, avoiding the temptation to 'intellectualize'; that is, force experience into neat models and, by so doing, erect defenses against considering what the new experience itself might mean. The data gathered through free-floating discussion can be used to develop hypotheses to explain the specific experience being studied and these can then be tested with the people concerned. It is also important to remain aware of the fact that because this approach to research is primarily concerned with what is tacit and unconscious it will have to confront the defenses that we all, to one degree or another, use to defend ourselves against bringing the tacit and the unconscious into consciousness for fear of the anxiety it may unleash. For this reason the researcher needs to look for what is odd, contradictory, and paradoxical in what people say. Researchers need to be primarily concerned not with factual, concretely descriptive language, but with the metaphors and the images people use.

From a complexity perspective research will be unable to yield predictors of or prescriptions for long-term innovative success—research will have to focus on explanation instead, on hypotheses about whole systems, their dynamics, the conditions under which they will display different kinds of dynamic, and the relationship between the dynamic and innovative success.

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