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AUTOGENESIS: A PERSPECTIVE ON THE PROCESS OF ORGANIZING*

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This paper presents a perspective on organizational theory called 'autogenesis'. This perspective has a long history in both the natural and social sciences, but is suggested particularly by recent developments in the field of self-organizing systems. According to this perspective, complex social organization can be explained in terms of the interplay of three distinct types of structure: (1) deep structure, which consists of a generative grammar (rules) for organizing; (2) elemental structure, which is the manifest form taken by individual social interactions; and (3) observed structure, which is the supra-individual group or organization as perceived by an observer of the system. The implications of this perspective for expanding the scope of theory and research on social organizations in general, and the process of organizing in particular, are discussed.
(PROCESS; ORGANIZING; SIMULATION)

Today, most organization theorists would agree that the field is shifting from the study of the statics of organization to the study of the dynamics of organizing (Mohr 1982; Mackenzie 1989). We are witnessing, at the core of organization theory research, the development of interest in time-related, dynamic phenomena studied with longitudinal methods. Work in this area includes, but is not limited to: research on social evolution and population ecology (Hannan and Freeman 1977, 1984; Carroll and Delacroix 1982); models of reorientation and metamorphosis (Romanelli and Tushman 1986); the study of life cycles of birth, growth, and death (Kimberly and Miles 1980); and the examination of the etiology of process itself (Weick 1977, 1979; Ranson, Hinings and Greenwood 1980; Mohr 1982; Mackenzie 1989).

Much of this work has proceeded within the metaphor of organizations as open-systems adapting to an external, changing environment (Morgan 1986, p. 235; Sandelands and Drazin 1989). Within this metaphor, two broad perspectives have emerged that comprise the majority of the work on organizing. One perspective attributes organization to factors of the environment, be these definite causal forces (Pfeffer and Salancik 1978), or indefinite dynamics of environmental selection (Hannan and Freeman 1977, 1984). We call this perspective *exogenesis* (literally, origin from without). The other perspective attributes organization to internal factors, be these design choices made by key managers (Child 1972; Fredrickson 1986), or conditions at the time of founding (Boekker 1989; Eisenhart and Schoonhoven 1990). We call this perspective *endogenesis* (or, literally, origin from within).

In recent years there has been a considerable debate on the question of which of these two perspectives deserves priority (Astley and Van de Ven 1983; Hrebiniak and

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Joyce 1985). Although this debate has produced many insights, its very existence suggests that neither perspective describes the organizing process in sufficient detail to be judged in the light of concrete facts. As we have argued elsewhere (Sandelands and Drazin 1989, pp. 459–460):

> The problem with both of these perspectives is that they describe a world that does not bear close scrutiny. They speak of entities and organizing processes that can neither be observed nor even specified. When we look behind the words, we find nothing so concrete or definite as the words suggest. If it is asked *how* environments or managers determine organization, the answer usually given is that they 'select' or 'choose' one that is appropriate. However, to say that organization is 'selected' or 'chosen' only incorporates the fact to be explained in the verb that does the explaining. The verbs 'to select' and 'to choose' do not refer to definite activities, but rather to consequences that unspecified activities might have. They present an appearance of process that only seems to explain organization.

As Ryle (1949, pp. 151–152) has pointed out, verbs such as selection and choice are ambiguous because they define process by the outcomes it produces. Given the fact of a choice or a selection, that is, that a particular form of organization exists, there must be a process of selection or choice that explains it. These "achievement verbs" (so called because they are defined by what they achieve) are inherently deceptive when used in explanation because they substitute a semantic connection between process and outcome for an empirical one. Genuine explanation, however, relies on the latter.

Inscrutable verbs such as selection and choice become necessary when theoretical terms become so abstract that relations between them cannot be experienced concretely. To connect entities such as environment, strategy and organization together, an appeal must be made to concepts of process that are equally abstract and unspecific. Although this makes for general and practically irrefutable explanation (who could doubt that organizations respond to their environments? or that managers decide about structure?) it leaves out of the account the mundane but theoretically crucial details of how specific actions and events produce and reproduce organizations over time (Giddens 1979).

Following Knorr-Cetina (1981, p. 30), we argue that the process of organizing can best be modelled at the level of observed actions and interactions of individuals. Toward this end we argue for a perspective on organizing that is logically distinct from the exogenetic and endogenetic perspectives described above. Although mindful of the dangers of neologism, we call this perspective *autogenesis* to emphasize its difference from other perspectives. Within an autogenetic perspective, organization occurs through the self-organizing capacities of individuals interacting in a social field. As we will show, the signal virtue of this perspective is that it provides a basis for concrete descriptions of the unfolding of organizing processes. Understanding the logic and principles of autogenesis should increase our ability to describe and chronicle organizing processes, free of a need to resort to achievement verbs and the undefined processes they signify.

Plan of the Paper. We begin with a brief review of the tradition of autogenetic thinking in the natural and social sciences. This review reports three overarching themes which form the basis for proposing a more articulated autogenetic perspective for organization theory. Next we propose such a perspective based on three types of structure, which we call *deep structure*, *elemental structure*, and *observed structure*. The implications of this perspective for developing and testing theories of complex organization are then discussed. We conclude with a general discussion of the role and place of autogenetic thinking in the theory and practice of organizational design.

Autogenesis in the Natural and Social Sciences

Recently, researchers in the natural and social science disciplines of mathematics, physics, chemistry, population biology, communication studies, organization theory, social psychology, economics and sociology have undertaken a new approach to studying a broad range of organizing processes (e.g., Allen and McGlade 1986; Brock and Sayers 1988; Day and Schafer 1985; Cohen, March and Olsen 1972; Miner 1987; Weick and Berlinger 1989; Masuch and LaPotin 1989; Devaney 1987; Rasmussen and Mosekiilde 1988; Hayes 1984; Krippendorff 1971). Despite differences of discipline, these researchers share common problems, language, theory, and methods geared toward understanding how organizing occurs. This emerging body of literature has been christened the science of self-organizing by its proponents (Ashby 1968; Prigogine and Stengers 1984; Yates 1987; Schieve and Allen 1982). We take its three mainstay ideas as starting points for proposing an autogenetic perspective for organization theory—these being that structure is emergent, produced by rules, and is a representation of behavior over time.

Structure Is Emergent

A fundamental postulate of self-organizing is that structure or order emerges out of the interactions of discrete microscopic entities, without outside intervention by the environment or by a designer. This concept is suggested most dramatically by recent findings that show that highly disordered systems, far from equilibrium, actually organize themselves in this manner (see Nicolis and Prigogine 1977; Prigogine and Allen 1982; Prigogine and Stengers 1984). Prigogine calls organization that emerges in this manner 'dissipative structures' to reflect their origins under conditions of near entropy.

A controversial notion surrounding the emergence of dissipative structures is that they arise through a process of self-organization. In self-organization, individual entities (molecules, cells, organisms, people) form structures based upon simple, inherent properties that govern their interactions. A classic example of self-organizing in the natural sciences (and the emergence of order under conditions of dissipation) is the appearance of a structure called a chemical clock. A chemical clock is a pattern of instantaneous shifts in the molecular structure of a chemical that produces precisely time periodic oscillations between two discrete states. This phenomenon occurs when the level of one state of the chemical randomly exceeds some threshold (through perhaps a chance fluctuation) and a cross-catalytic relationship is set up such that all the molecules "communicate" with each other and change structure simultaneously (see Prigogine and Stengers 1984, pp. 146–148).

The concept of structural emergence is rooted in the social sciences as well as the natural sciences. Durkheim (1896/1932) employed this idea as the basis of his theory of the division of labor and for his general conception of sociological method (i.e., 'methodological individualism'). A similar idea guided Parker-Follett's (1937) classic concept of organization control as a "self-generating process" based on the "inter-functioning of parts" (p. 169). Elias (1978, p. 12) maintained that "the secret of sociogenesis and social dynamics" lies in "the interweaving of innumerable individual interests and intentions" such that "something eventually emerges that, as it turns out, has neither been planned nor intended by any single individual."

One central idea in the literature on emergence is that structure has primarily a conceptual or cognitive status, which exists in the mind of the observer as a representation of something more than interactions among individuals (Allport 1962; Homans 1950; Collins 1981). According to Berger and Luckmann (1966, p. 57), despite the objectivity normally associated with the experience of institutionalized life, social organization does not and cannot acquire an *Ontological* status apart from the social action that produced it. This idea is repeated among contemporary social interactionists who insist that structure is a reification or objectification—highly useful for the purpose of interpreting and responding to social life, but a reification nonetheless. According to Knorr-Cetina: "The outcomes of [individual] practices are *representations* which thrive upon an alleged correspondence to that which they represent, but which at the same time can be seen as highly situated constructions which involve several layers of interpretation" (emphasis added, 1981, p. 34). As an example from organizational life consider watching people from different departments work together as a team toward the completion of a task. As outside observers we could construct this episode of cross-functional behavior as representing a matrix organization. 'Matrix' itself does not exist, except as a useful analytical category shared among observers.

Probably the most ardent and influential opponent of the idea that structures (in particular, groups) are autonomous entities (having unique properties of cohesion, norms, influence, and action) is Allport (1962), who argues that there is nothing more to groups than the behaviors of their members. He suggests that many of the dilemmas which have exercised group theorists over the years (particularly dilemmas of understanding processes of organization) are the result of a reification of structure. He argues that the problem of explaining group-level phenomena (what he calls the master problem of social psychology) is to specify, in unambiguous terms, just what is occurring between and among involved individuals.

On the other side, there are those who argue that emergent structures truly exist as genuine facts (Durkheim 1933; Parker-Follett 1937; Mandelbaum 1955; Mayhew 1980; Szmatka 1989; Warriner 1973; White 1947). According to Mandelbaum (1955, p. 307) "one cannot understand the actions of human beings as members of a society unless one assumes that there is a group of facts which I shall term 'societal facts' which are as ultimate as those facts which are 'psychological' in character. In speaking of 'societal' facts, I refer to any facts concerning the forms of organization present in a society". White (1947, p. 693) speaks similarly of the social form of 'culture' which has "in a very real sense, an extra-somatic character. Although made possible only by the organisms of human beings, once in existence and under way it has a life of its own. Its behavior is determined by its own laws, not by the laws of human organisms." For White, Mandelbaum, and others (Webster 1973; Mayhew 1980) organization theories cannot be valid until organizations are recognized as genuine entities. To these authors sociological method rests wholly on the basic principle that social facts must be studied as things, that is, as realities external to the individual (see Durkheim 1915/1982).

Although the debate about the objectivity of emergent structures is far from settled, the two sides agree on two general points. One is that social structure is not simply an aggregation of individual actions (Mayhew 1980), but has unique properties not possessed by individuals alone. Several writers have remarked how macroscopic properties "...chronically escape the initiators intentions..." (Giddens 1979, p. 44) and how they are often surprising and counter-intutitive to the people that create them (Schelling 1978, p. 51; Feldman 1989).

The second point of agreement is that social structure is a mental construct (Berger and Luckmann 1966, pp. 45–63). The existence of organizations depends upon categorization schemes used by observers to abstract information and give meaning to the flow of experience. These abstractions can be shared by observers and thus have the property of being cultural products (Geertz 1973; Giddens 1979). Because they are conceptual abstractions, organizations belong to a general domain of social understanding. Their meaning can be produced, modified, and reproduced inter-subjectively (Habermas 1979) and transmitted inter-generationally through socialization (Berger and Luckmann 1966). Thus, observers of organizations have both individual and cultural knowledge of the social systems they populate.

The concept of emergent structure suggests that our understanding of complex social organization arises at a macroscopic level which is distinct from the microscopic level of individual elements in interaction. A structure emerges whose characteristics are a property of the collective and could not be inferred from the elements in isolation or from their interactions (Geertz 1973; Prigogine and Allen 1982, p. 7; Poundstone 1984).

Structure Is Produced by Rules

A second theme of self-organizing is that the interactions among microscopic entities that generate structure are governed by rules. This idea is well illustrated by models of physical and social systems called cellular automata (Von Neumann 1951; Hayes 1984; Schelling 1978; Axelrod 1984; Friedhoff 1989). A cellular automata is a uniform array of identical cells, as in a matrix, where each cell represents a discrete entity, such as a molecule within a snowflake, or an individual within a social field. In a cellular automata each cell interacts with its neighboring cells according to specific rules of interaction which operate recursively over time. For example, Schelling (1978) proposes that homeowners make decisions to remain in their homes, or to sell, based upon rules having to do with the ethnic diversity of their neighborhoods. Each round of sell/remain decisions has an impact on ethnic diversity, which then becomes the input for the next round of decisions. The rules are recursive due to their repetitively applied nature.

Even when directed by limited, simple rules, these cellular systems have been shown to produce complex, even spectacular, structures over time (Poundstone 1984). Other recursive models, called fractal structures, compound simple geometric formulas (rules) at increasing levels of detail to build elaborate structural models (Mandelbrot 1982). Fractal structures have been successfully used as models of such diverse organizational phenomena as the incidence of earthquakes, noise in transmission lines, and the growth of complex biological structures such as vascular and bronchial systems (Gleick 1987). Recursive models have also been used to explain the enactment of environments, as in the social creation of speculative bubbles in the panic buying of commodities (Abolofia and Kilduff 1988).

Allport (1962) provides an early view of the role of rules in generating social structure. To Allport, structure organizes itself based on individual tendencies which can be described by rules. When one person needs or seeks another person there arises a "... predictive operating condition that we can call a 'collective structure'...". By virtue of the interdependence established between persons, this structure is able to achieve a kind of enduring integration. Organization emerges as a result of other-directed behaviors arranged in reciprocating and "self-closing" patterns which Allport calls cyclical acts and cyclical act sequences. Collective structuring is the result of the heightened probability of gaining satisfaction through integrated or articulated behaviors, a probability that is afforded by the presence and potential interactions of others. This process can be described in terms of a set of recursively operating rules that guide individuals as they seek to satisfy their own needs.

Weick (1979) presents a theory of organizing that is akin to Allport's (a debt Weick is quick to acknowledge), but which goes much further to provide details about how the process operates. For Weick, as for Allport, organizing consists of the inter-structuring of individual behaviors. The basic units of organizing are "double interacts." These are iterative, rule-based sequences of social behavior corresponding to an action by one person, a response by another, and a response to the response by the first. Structure is produced by the interlocking of interacts.

Rules are also central in theories of social structuring based on economic exchange and organizational transactions (Homans 1961; Schelling 1978; Salancik and Leblebici 1988). According to these theories, rational actors respond to others in their environment by entering or not entering into exchange relationships with them. These responses are governed by tacit rules or rational decision-making which operate recursively for each actor. The rules constitute a 'deep structure' that generates relationships among actors and produces macro-order. Giddens (1981, p. 72), for example, differentiates between the deep structures, which have a "virtual existence" and the system of relationships between actors which are situated in time and space. Organizing is the process of producing observable, nameable systems from deep structure.

Axelrod's recent work provides an excellent example of a rule-based system that generates structure (1984). He demonstrates how a particular kind of social arrangement, a norm for cooperation, can evolve from the separately motivated actions of individuals. In this simulation, multiple actors are arranged in a social field defined by an $R \times C$ matrix in which each cell represents an actor. This matrix is folded upon itself (left to right, top to bottom) to create a doughnut-shaped surface that has no edges. In each iteration of the game, each actor plays a Prisoner's Dilemma game with every other actor in his immediate neighborhood (north, east, south, and west) and receives a score. A total score for each individual is then computed as the average of the four scores with the other actors. All actors follow the same transition rule whereby they 'choose' their next action by copying the strategy used by the highest scoring actor in their immediate neighborhood. In a representative analysis, Axelrod compared the viability of 63 different decision strategies which varied according to whether they were essentially cooperative or uncooperative in orientation (each strategy being represented 4 times in a matrix of size 14 by 18). Interestingly, he found that a stable equilibrium was reached when noncooperative strategies were eliminated in favor of cooperative strategies.

The provocative implication of all these models is that complex structures can be explained as a result of the recursive application of simple rules that govern interaction among component parts (Hofstadter 1985). Recursively applied rules are essential in self-organizing processes.

Structuring as a Moment in Time

Structure is not merely a static property of a system, but rather a perceived moment in time in a dynamic organizing process. Thus, a great deal of research on self-organizing involves developing equations, or other forms of rules, that can be used to graphically portray the unfolding of emergent structure over time.

To analyze the relationship between structure and process, researchers have increasingly turned to the computer as a tool for capturing dynamic systems (Friedhoff 1989). Computer simulations make it possible to produce both direct and indirect visual representations of self-organizing systems as they evolve over time (Abraham and Shaw 1987; Gleick 1987; Lorenz 1987). Direct representations have been used in studies involving cellular automata. Allen (1982), for example, modelled the growth of population centers using a system of recursive rules. For each iteration of the system he plotted the development patterns of cities and rural areas. The sequence of plots enabled him to directly see the process of urbanization as it unfolded over time. Schelling (1978) used a cellular automata model to graphically portray segregation in housing markets. Similarly, Axelrod (1984) modeled the outcomes of his rule-based simulation of the diffusion of norms of cooperation.

Interesting patterns were found among the norms—in particular, strategies tended to cluster together, forming a kind of division of labor, even though the initial assignment to a position in the field was random.

Another means of representing structure as a self-organizing process over time has been to plot the values of key system parameters against each other, or against time, in what is called "phase space" (Gleick 1987). Research has shown that these plots can be useful as descriptions of the long-term behavior of complex organizing processes. Pictures of phase space are powerful analytical tools because they make system changes easier to see. Prigogine and Stengers (1984) graphed the chemical clock discussed above by showing the relative values of each state of the chemical plotted against each other. Analysis of the phase space revealed a region of bifurcation which produces the oscillation behavior characteristic of the clock. Using these maps has allowed researchers to analyze dynamic structures that could not otherwise be seen.

An Autogenetic Perspective on Social Organizations

In this section, we build on the previous literature to detail how an autogenetic perspective can be applied to the study of social organization. We suggest the term 'autogenesis' to denote a self-organizing perspective on how organizing occurs, and to contrast this approach to exogenetic and endogenetic models. Expressed simply, autogenesis is the idea that organization can be explained by observation and categorization of the interactions of independent actors whose behavior is governed by a system of recursively applied rules. Autogenesis is pre-eminently a process-oriented perspective because it focuses on explaining how organization emerges, rather than why it emerges (Mohr 1982).

First, we describe the autogenesis of social organizations in terms of three distinct types of structure. Then we describe how these types of structure can be juxtaposed to explain how social organization arises. Finally, we highlight new directions for empirical research on organizing processes based on an autogenetic perspective.

Three Levels of Structure

The autogenesis of social organization can be analyzed in terms of three different types of structure: (1) deep structure, which consists of rules that generate and govern individual behavior and interactions, (2) elemental structure, consisting of interactions among individual actors, and (3) observed structure, comprised of the categories and terms that apply to the perceptions of social interaction as collectives by observers. As depicted in Table 1, these three types of structure can be arranged hierarchically as levels which define the autogenetic process as a whole. (See Giddens 1981 for an analysis of a somewhat similar hierarchy of structure; Geertz 1973 for a

TABLE 1
Three Levels of Structure in Autogenesis

Level	Definition	Key Properties
DEEP STRUCTURE	Tacit rules that govern actors in their actions and interactions	Virtual and unobserved, Generative—The dynamic recursive function that creates elemental and observed structures.
ELEMENTAL STRUCTURE	States of actors, Interactions among actors	Observed in time and space, consists of micro-level structure.
OBSERVED STRUCTURE	Social facts constituted by interactions among social actors.	Observed in time and space, consists of macro-level structure.

discussion of layers of cultural analysis in the production of ethnography; DiMaggio 1986 for an analysis of levels of interpretation in interorganizational relationships; and Willmott 1981 for a discussion on the necessity to separate structure as interaction and structure as constraint.)

(1) *Rules as Deep Structure.* The first level of structure in the autogenetic perspective consists of the rules that govern the actions and interactions of individuals. These rules, used as guidelines for action by individuals to economize on their interactions with others, have two general effects. First, they obligate the focal actor to act a certain way in that setting. Second, they elicit expectations in other interactants regarding the meaning of that action and the response required (Goffman 1967, p. 49; Graen and Scandura 1987). Rules play a central role in the model because they generate the observable patterns of interaction over time that make up the organizing process. Dynamic processes can be summarized by generative rules and these rules are an efficient description of that process (Chomsky 1972; Goffman 1967; Gleick 1987).

In a simple autogenetic model, all actors are governed by the same set of rules. More complex models might describe actors using different sets of rules, but, in all cases, the rules operate in the same way to select actions based on available information. For example, rules governing social interaction would most likely rely on information collected about other actors in physical or social proximity. A focal actor might scan his or her immediate neighborhood, gather information about the states of other actors, and on that basis "decide" to preserve or change his/her state and/or establish or terminate interactions with one or more other actors. Such rules could be considered as a set of input/output statements linking positional information to action.

As an example, consider the emergence of a division of labor. Suppose that a number of individuals are located together and engaged in a production process consisting of a number of different operations. Suppose further that all individuals are capable of performing all operations. Thus, at one extreme, each person could perform all of the operations (no division of labor); at the other extreme, each individual could perform a single operation (maximum division of labor); and in-between, each individual could perform a (possibly varying) subset of operations (intermediate division of labor). The question is: How does a particular division of labor occur? This question could be answered by describing the rules which determine how the actors in this system behave. For example, one rule might be that each individual works at a given operation as long as the required raw materials are immediately available (e.g., tools, in-process inventory). Another rule might be that when raw materials are exhausted, the individual switches to a different work operation for which raw materials are abundant. Now, if we assume only the slightest variability in the skill rate at which workers perform different operations, it would be possible to show that workers following these two rules can settle into a division of labor whereby each performs only a subset of the total number of operations. This would occur as soon as neighboring actors began to share raw materials and in-process inventories instead of keeping them to themselves and moving sequentially through every production operation. Moreover, because such a pattern may result in enhanced productive efficiency, it may be reinforced and become institutionalized. Almost certainly, the division of labor's precise form and history would depend on a host of factors, such as the number of individuals, their talents, their locations relative to one another, the ease of communication and exchange between them, the number of production operations, their durations, and the time required to move between operations.

The Nature of Rules. Although rules can be of almost any kind and scope, and can specify a wide range of states, actions and interactions, they are presumed to have two general characteristics: bounded information and recursiveness. First, actors are assumed to have only bounded knowledge of the social milieu, so that no single actor can fully comprehend or anticipate the states of all other actors (Berger and Luckmann 1966). Each actor must therefore rely upon information that is available in his/her immediate environment, however that environment is defined (physical proximity or social proximity, as examples). This is called positional information. In the division of labor example, positional information for each individual might consist of knowledge of the inventories and skills of the four closest other workers.

Recursiveness is the idea that rules are constantly in force and applied iteratively as circumstances and information change. Thus, the output (states, interactions) of one application of the rules becomes the input (positional information) for the next iteration of the rules. This recursiveness of rules accounts for their structural generativity.

Different organizing processes are likely to be governed by different rules. For example, the rules for movement and talk at a cocktail party are likely to differ from the rules for action in a production process, and differ again from the rules for deciding to cooperate or not in a Prisoner's Dilemma game. That different rules operate in these cases is attested to by the different social structures they produce. At the same time, however, there are likely to be certain rules which generalize across situations, if only because human behavior is not infinitely variable, but retains a distinctively human character across situations.

Uncovering Rules. In many cases it may be difficult to confidently discern the rules underlying individual action. As Chomsky (1972) has noted in respect to language, and Goffman (1967, pp. 49–50) has noted in respect to interpersonal behavior, individuals are typically unaware of the rules governing their actions. This suggests that, as a point of method, researchers have little choice but to observe patterns of overt behavior and work backward to infer rules that could have produced them—a procedure that is bound to produce multiple and competing conceptions of rules. The task of inferring rules is helped, however, by instances when rules break down, or when they are violated for some reason. For example, breaking an important rule of social interaction is likely to invite admonitions from others, who may feel resentful or indignant when certain obligations are not met, or when certain expectations are disappointed (Goffman 1967). Rules or rule-making may also be uncovered when new technologies enter into existing organizations and social actors redefine their relationships (Barley 1986, 1990).

Preliminary ideas about the rules which guide social behavior and thus produce social organization can be gleaned from the sizable literatures of social psychology, micro-sociology, and micro-organizational behavior (Graen and Scandura 1987). These literatures are full of models of individual behavior in social settings—and include extensive descriptions of individual decision making and motivation, person perception and attribution, social comparison and perceptions of equity, self-justification, self-presentation, individuation, social influence, and leadership. Add to this a growing number of models which specifically attempt to link individual and organizational outcomes—for example, models which show how the bounded rationality of individuals leads to unintended consequences for organizations.

Origins of Rules. Rules originate from the habituation of action and interaction. When faced with a particular interpersonal situation an individual responds programmatically based on a limited array of choices that are the result of past experience and socialization (March and Simon 1958). Interaction rules are typifications of reciprocal action (Berger and Luckmann 1966, p. 51) which link individual actions in predictable ways, and thus carry along with them certain expectations. In situation A, response B should be likely to result in outcome C.

Rules can arise de novo from interactions among strangers who have no common culture or prior experiences to draw upon. For example, as two strangers act in the presence of each other, their independently motivated actions provide information about their repertoire of behaviors and habits which make their future behavior more predictable. Based on this predictability, the two strangers may begin to assume roles relative to one another, which then develop into mutual expectations, and eventually even into obligations. In this primitive way, a simple organization emerges. Such patterns of conduct are likely to be reinforced and repeated when both parties are better off for having interacted (Berger and Luckmann 1966, p. 54).

Rules also can extend beyond the conditions of their founding and be passed down from generation to generation. In established organizations, the individual encounters a world of already existing rules (which were once new and socially created) and he or she experiences them as external and coercive facts (Berger and Luckmann 1966, p. 55). The individual is socialized to a set of obligations regarding his or her own behavior as well as expectations that certain attempts at interaction will be reciprocated in typical ways. In this manner, an expanded order of expectations arises among multiple individuals which institutionalizes the interaction and thereby makes it predictable. Thus, there is a paradoxical aspect to rules. On one hand they are produced by social action—their institutional form being objectivated human activity. On the other hand, they are experienced as something tangible and often felt as constraints. This experienced quality gives rules their deep structural character.

Changes in Rules over Time. Rules are structures themselves, and are produced by rule-based autogenetic processes. Their temporal intransigence, however, endows them with a generative character. This temporal intransigence results from the fact that autogenetic processes, as developed in this paper, are self-modifying games (Hofstadter 1985, p. 82). There are at least two levels of rules in a self-modifying game, with others possible. First are primary rules which are the generative mechanisms that guide individual behavior and interactions among individuals. These are the rules to which we have been referring and which produce directly the observable structures that we call organizations. For example, a rule that explains the exchange of work in the formation of a division of labor is a primary rule. Secondary rules are those rules which govern how primary rules are changed. These rules are more immutable than primary rules but are subject to change themselves. The embeddedness of rules results in a system wherein rules may be changed, but the changes are governed by rules themselves. The players in a rule-based game may reflect on current rules, and change or add new rules. Children at play provide an excellent example of secondary rules. Some rule-based game is devised and played for a while, until one child declares a rule as unfair. A change in the rule is then made, perhaps by majority vote. Hence games like these are self-modifying. However, because there is some difficulty in changing rules (and more difficulty in changing the rule-changing rules), there is some stability built into the system. The rules that govern play can be changed, but not without some expenditure of effort.

Autogenetic processes can therefore allow for learning to occur and the embedded nature of the rules suggests that learning may be of the type described by Bateson (1972, 1979) and Argyris and Schon (1974). Primary rules reflect model I learning, secondary rules reflect model II learning, and higher levels of rules may reflect deutero-learning. The focus of the current autogenetic model is on the simple generation of organization from a set of primary rules.

(2) *Elemental Structure as Individual Behavior and Interaction.* Our concepts of deep structure and elemental structure correspond to what Morgan calls an "implicate (or enfolded) order" and an "explicate (or unfolded) order" (1986, pp. 233–234). The implicate order contains within it "logics of change" that are generative in character while the explicate order consists of the world of organization that we normally see about us. Much of organization theory has been concerned with understanding relationships *within* the explicate order rather understanding how that order unfolds. This leads to the development of models of change which are exogenetic or endogenetic in character. However, if we view the world as an unfolded empirical reality then "...we can best understand the nature of organization by decoding the logics of transformation and change through which this reality unfolds." (Morgan 1986, p. 235).

The rules that comprise deep structure produce what observers see as actions and interactions among individuals. These actions and interactions constitute a distinct order that we call elemental structure. Elemental structures change or unfold with each iteration of the recursively applied rules to produce a temporal stream of activity that is the explicated process of organizing. In contrast to the rules, which are unobserved, this level of structure is observable and exists in time and space.

Continuing with the division of labor example introduced above, elemental structure in this case would consist of the distribution of production operations across individuals (states), exchanges of in-process inventories among individuals (interactions), and the changes in states and interactions with each iteration of the rules. It would not consist of the rules, which are inferable but not observable, nor would it yet consist of any perception of a more macroscopic structure or pattern.

At this level of structure, an observer experiences the behaviors and interactions among the workers in a disaggregated manner. Only a portion of the social field is glimpsed at one time, with the actions and interactions of only a few individuals discerned. This is the kind of social structure with which we are natively most familiar, which appeals most directly to our senses. Because we are especially aware of individuals in our environment we tend to regard social structure at this level as uniquely objective and concrete—and more so than structure at the level of rules, or at the level of observed structure.

(3) *Observed Structure.* Although elemental structure is what we most often see in daily observations of social life, we also discern more macroscopic structures which have global properties and characteristics that differ from the disaggregated behaviors and interactions of individuals. For example, in the case of the division of labor, a group of workers might emerge in one part of the social field and engage in one production operation, while adjacent to them might be a group which does a different operation. These clusters might be named "work groups" or "cartels" or "suppliers" depending upon the actual elemental structure and the categorical proclivities of the observer. We call this level of structure 'observed structure'. (See DiMaggio 1986, for a related discussion in network analysis.)

Observed structure includes entities such as groups, teams, coalitions, business units, departments, and whole organizations. Observed structure also includes various relations which may be postulated between entities—such as causality, constraint, intention, or mimesis.

In classical organization theory, observed structure is conceived in the tradition of Parsonian structural-functionalism (Dow 1988). Based on the metaphor of the equilibrium-seeking organism situated in an external environment, this theoretical tradition begins with concepts of the organization and the environment and conceptualizes organizing in terms of dynamics that fit or adapt the former to the latter. Reflecting this tradition, a central debate in organization theory today centers on whether changes in organization are directly caused by the environment, or whether environmental effects are mediated by perceptions, assessments, and choices of decision-making elites within organizations (see Astley and Van de Ven 1983). From the perspective of autogenesis, however, observed structure is simply one of three basic kinds of structure. There can be no controversy about how organizations adapt to environments because an explanation of observed structure is not sought at the level of structure called observed structure, but rather at the level of either elemental structure, or more essentially still, at the level of deep structure: Both environment and organization are observed structures and emerge from our observation and categorization of elemental structures.

Indeed, from the perspective of autogenesis, the idea of environment explaining anything is suspect, if only because environment is not a definite thing:

> The word [environment] has no specific referent; it stands for no particular thing or set of things, and has no definite form or extension. It is everything that is not the organization. Its meaning is given by its use in theory, where it functions as a kind of sensitizing concept. Environment is the idea that there is something outside the organization that somehow explains what is inside. As a point of logic, environment could not determine organization because it is defined by organization (Sandelands and Drazin 1989, p. 463).

Thus, although the metaphor of organismic adaptation resides within the level of observed structure, it is not an element of autogenetic reasoning.

Observed Structure and the Role of the Observer. The term structure usually refers to something solid; something that can be touched, felt, or even held onto for support. For the most part, classical organization theory does not take exception to this tradition; indeed, it seems to have borrowed the term from disciplines where a more concrete use of the term is perhaps more appropriate (e.g., architecture, engineering, biology). However, when an autogenetic perspective is taken, the nature of structure becomes more elusive. For example, observed social structure is what is seen and named amidst the activity of organization members (i.e., elemental structure). It is both objective and subjective—objective in that it could not exist but for the activities of individuals and the rules that govern their interaction; and subjective in that it could not exist but for a perceiver to identify its form. Because organization is what observers see, there is no separating the organization as object from the perceiving subject, and no telling whether observed structures truly exist. All that can be said for sure is that these structures 'appear' to an observer. This means that theories or organizing must take the observer into account, as well as actions and events occurring in the social field.

One implication of the role of the observer in the conception of structure is that familiar terms, such as organization and environment (among a host of other terms), become more problematic. We see that they are not immutable things, but partly artificial constructs invoked by the observer to bring order and sense to a confusing world. Structural entities such as organization or environment are not absolutely given, but are representations of an ever moving and evolving social field. Their boundaries are neither intrinsic nor discrete, but subject always to interpretation and revision.

Along these lines, Morgan (1986, p. 238) has suggested that our basic conception of organizations as entities set apart from their environments is a result of the particular and idiosyncratic vantage that we take when observing social behavior. We are attuned to seeing objects and events as belonging or not belonging to the organization —part of the organization or part of its environment. This being the case, it is unilluminating to explain organizations as adaptations to environments since both organization and environment are defined by the same set of facts (see Morgan 1986, Sandelands and Drazin 1989).

A second implication of this role of the observer is an issue that might be called "clock speed". Imagine a map being drawn on a computer screen for the matrix that represents a distribution of strategies in Axelrod's simulation. With each iteration, the map changes to show the next distribution, perhaps with colors or numbers representing the strategies adopted (Axelrod used numbers). Our experience of organizing and of structure would vary greatly depending on the clock speed or time interval between changes in the map. At very slow speed, all we would see is a distribution of actors and the states they are in, without very much of an experience of transition or change. Indeed, unless there were obvious clusters of states, we would probably be hard-pressed to understand what was going on. Our experience would be that of a set of disaggregated individuals. At higher speeds, we might begin to see temporal patterns which we could then name and tell stories about. At still higher clock speeds we might see events and transformations that were previously unnoticed (our perceptual ability being limited by the slower clock speed).

As a practical example, consider how information technology has changed observed structure. As a result of the quickened pace of communication and social interchange brought about by the introduction of new technologies we can now appreciate interconnections and ramifications of action that were too slow and too obscure to be seen before. Now, with the introduction of computerized inventory control processes, it is possible to see how a customer order placed in Cincinnati can immediately affect the actions of a warehouse manager in Anaheim, which can immediately affect the actions of a shipper in Los Angeles, which can immediately affect a truck driver en route from Reno. This same order could have immediate effects on the supply side as well by affecting a purchasing office in San Francisco, a buyer in Hong Kong, and perhaps even a manufacturer in Singapore. We can now see that people are connected in ways that were not obvious before. Old ways of seeing are displaced by new ones.

What we see therefore depends on how we see. Our understanding of organizations depends on our position as observers of unfolding processes. Taking an autogenetic perspective encourages us to look at different levels of structure and process and to discern connections between them. By conceiving of organizational theory this way it is possible to explore alternative ways of seeing and gain valuable insights about the dynamics of organizing.

Levels of Structure and Organization Theory

Explanation, as Durkheim (1915/1982) pointed out, involves juxtaposing ways of seeing so that one illuminates another. For example, a whole may be explained by a view of its parts (or vice versa), or an instance may be explained by general principles or covering laws (or vice versa). The signal contribution of the autogenetic perspective for organization theory is that it identifies three alternative views of structure which can be juxtaposed for purposes of explanation. This contrasts with the endogenetic and exogenetic perspectives described at the outset, which present only a single view of organizations—that of observed structure, and therefore cannot provide a sufficient basis for genuine explanation (Sandelands and Drazin 1989).

From the perspective of autogenesis the different levels of structure are mutually illuminating. Deep structure offers insights into elemental structure because elemental structure is what one sees when rules operate. Similarly elemental structure offers insights into rules because rules are redescriptions of elemental structure at a deeper level. Elemental structure illuminates observed structure because observed structure is what is discerned amidst the bustle of elemental structure. Observed structure reflects back upon and illuminates elemental structure when observed structures are analyzed into constituent elements. The task of organization theory is to bring these alternative views close enough together so that the eye or imagination can move easily between them. One kind of structure is explained when it is possible to see that a different kind of structure relates to it.

By making alternative views of structure explicit, the autogenetic perspective avoids the nettlesome problems of reductionism and reification that plague organization theory. Analytical reduction is a valid and venerable mode of explanation, but only when both the whole and its parts can be observed. Too often in organization theory the whole is unobserved, and, as a result, is then identified with its parts. This leads in turn to problems of definition which give reductionism its bad name. What happens to the organization when its members go home at night, or are replaced? Does it remain the same organization? More pointedly, what happens when replaced members reconvene elsewhere (as happens with baseball teams on Old Timer's Days, and is beginning to happen with old rock and roll bands)? Which is the real organization? Then there are problems of boundaries. What are the criteria for deciding whether a given individual is part of an organization? What about individuals who "belong" to multiple organizations (see Katz and Kahn 1966; Barnard 1938)? Can a person be part of an organization even if he/she never interacts with other "members"? These droll puzzles symptomize some very serious conceptual problems (Nozick 1981).

Close cousin to reductionism is the problem of reification. Whitehead (1924) described reification aptly as the fallacy of misplaced concreteness. According to those who define organizations exclusively at the level of elemental structure (e.g., Allport 1962), all talk about organizations per se is reification and evidence of undisciplined thinking. The autogenetic perspective avoids the problem of reification by proposing a genuine level of analysis which is different from elemental structure (namely, observed structure), while setting aside the question of its objective status. It claims only that organization is logically distinct from the persons and actions which constitute elemental structure. On this account, the concept of organization is not completely reducible to individual action.

The concept of organization defined in autogenesis is distinct also from concepts of organization based on certain metaphors, such as organism, machine, or mind. These types of metaphors are also reifications and illegitimate unless secured by factual comparisons between the metaphorical entity and organizations. However, because such comparisons are rarely made, metaphors of organization are rarely demonstrated to have the substance that is claimed for them. The autogenetic perspective allows for a genuine study of organizations, and, indeed, specifies that any such study must include a definite concept of observed structure.

Research Directions

In both the natural and social sciences, autogenetic systems have been studied in various ways, though pre-eminently by computer simulation (Hofstadter 1985; Gleick 1987; Friedhoff 1989). The principal advantage of computer simulation is that it presents a time-dependent and time-consuming process in a manageable way. In addition, because temporal patterns are not easily described (indeed, cannot be fully described), it is convenient that a computer can simulate processes and present their important features visually (see Krippendorff 1971).

A promising use of computers to model the autogenesis of social organizations is the cellular automaton employed by Axelrod (1984). Cellular automata can represent all the three levels of structure introduced in this paper. First, they consist of rules which operate on individual actors (represented as cells in a matrix). These actors (cells) scan their neighborhoods and take action based on the actions of neighboring actors. The researcher seeds the initial distribution of actors, states and distances, but allows future distributions (social structure) to be determined solely by the rules. Cellular automata allow rules to be applied recursively such that the outputs of one iteration are the inputs to the next interaction. Second, the results of these simulations can be represented visually in order to display elemental structure as it unfolds across iterations. For example, maps of social structure can be produced which visually present the condition of each actor and the distance in social space between them. These maps also can be displayed in sequence, like a motion picture, to show how the system evolves over time. Finally, the visual presentation of the elemental structure allows the researcher to observe the process as a whole and to identify in this totality higher-order, observed structures (Friedhoff 1989).

We return to the division of labor example to illuminate a possible autogenetic research study. To us, the division of labor problem is a core one because it deals directly with how organization comes about from an unorganized social field. One approach to this problem would be to begin with a particular division of labor in mind, for example, a sequential organization of tasks, and then try to induce a set of rules (deep structure) capable of reproducing the division of labor using a cellular automata type of simulation. These rules might be gleaned through relevant literatures or through the ethnographic observation of organizations that have sequential divisions of labor. The researcher would incorporate an initial set of rules in a simulation that would allow these rules to be iterated over time. The model could represent each individual as a cell in a matrix and link individuals to each by either geographic proximity or by some form of social influence (i.e., friendship). The simulation would also allow for a visual representation of the underlying model, showing the state of each worker in each iteration. In this particular example, the state to be represented would likely include which step or steps of the production process each worker was engaging in. As the simulation unfolded, the elemental structure would be portrayed for each iteration, allowing the researcher to visualize the dynamic organizing process. Presumably, with a correct set of rules, the simulation would proceed from some unorganized initial state, through intermediate states, until an observed structure emerged that represented the sought-after division of labor. In this case, it might be a particular arrangement of elemental structure where, say, each step of the production process was done by a group of workers, and the workers were arrayed geographically in A, B, C order. Results of such a simulation could be reported by (1) detailing the rule set that generated the division of labor, and (2) providing figures which represented beginning, intermediate, and final distributions of workers.

A second research approach would be more exploratory in nature. It would consist of developing some interesting set of social rules, and then observing the patterns of behavior these rules produced. Here, the focus would be an investigation of the rules themselves, rather than on some final outcome state—i.e., how they function, what patterns of elemental and observed structures they produce, and how they interact with other rules. As an example of this type of research project, let us start by assuming that some initial simulation, such as the sequential division of labor, has been created. The researcher might then be interested in studying the effects of the insertion or deletion of a rule on the unfolding order. For example a rule might be tested that related to the degree of specialization that workers might tolerate. Such a rule could be played off against needs in the systems to attain some degree of efficiency.

The power of both of these approaches is suggested by the variety of research questions they might answer. One interesting question would concern gauging the effects of small variations or disturbances in the initial conditions of the system (i.e., the distribution of workers and their relative talents for each of the three production steps) on the ability of the system to organize. If such effects were found to be small, then the organizing system would be robust with respect to starting conditions. However, if the effects of initial distributions are large, then the system is context dependent, thus suggesting the need to specify initial conditions in describing the organizing process. Moreover, it may be possible to identify rules or classes of rules that lead either to equifinality or to generation of structural variation (Aldrich 1979). Similarly, one could investigate the effects of adding or removing particular rules on the ability of a system to duplicate a structure. It may be that a simple rule change can lead to the production of markedly different types of systems.

Other questions arise around the ability of a system to organize in the first place, or to become stable. It seems likely that there will be certain threshold parameters—e.g., of numbers or densities of actors—below which organizing does not occur, or below which a system is incapable of maintaining an organizing capacity. In addition, some systems of rules may result in stability in key parameters over time, while others could produce periodic oscillations or chaos. Again, there may be rules, or types of rules, which generate quite different types of dynamic performance.

Aside from issues of analyzing global properties of self-organizing systems, there are also intermediate-level issues of organizing to investigate. When any cellular automaton is iterated recursively it produces a fantastic array of temporal patterns (Poundstone 1984). These patterns are intermediary structures between the initial chaotic array and eventual self-organization. Research at this level requires that the system be seen by the researcher in order for the temporal patterns to be recognized and named.

Discussion

Mohr (1982) has observed that one of the biggest impediments to the adoption of process theory has been the persistence of variance theory thinking. He attributes this to the fact that social scientists have been trained to think about theories in variance terms in preparation for testing these theories using conventional statistical techniques. This results in researchers thinking process, but writing about variance (p. 13). Sandelands and Drazin (1989) have noted that one of the consequences of force fitting process into variance theory is the creation of language that gives the illusion of process when a process has in fact not been described. It seems that the researcher who tries to develop a process theory, but works within a variance framework, always runs into a logical bind with the only escape being to use process-like achievement verbs, such as 'environmental selection' or 'strategic choice'. These verbs become part of the metatheoretical background of an argument for process but are never actually described or tested. Theories which use words like these tell stories which sound process-like but which lack genuine process content. According to Mohr (1982, p. 13), this practice detracts from the complete and useful development of true process theories.

Explaining how organization comes about is a problem that recently has been addressed by a wide range of disciplines that, despite their diversity, share in the development of a core set of problems, principles, methods and language to deal with questions about process. Out of this Zeitgeist has arisen a frame of reference that has the capacity to answer many questions about process in organization theory. A useful synthesis of this new paradigm with the process theories proposed by Allport, Weick and Axelrod and others now seems possible.

This paper has argued for a process perspective called autogenesis based on the principles and methods of this new approach. Autogenesis itself is not a theory of organizing, but an orientation to theory that evokes a language, conceptual principles, and a research approach that can inform the development of specific process theories. It is offered as a way to think about organizing that has the potential to allow for the development and testing of truly processual theories. By recognizing that observed social structure is the way activities of individuals appear when viewed macroscopically, the autogenetic perspective calls attention to actions and rules at the individual level, rather than to variance theory concepts such as organization and environment as the generators of structure. The autogenetic perspective allows researchers to go beyond the constraints of past paradigms and to avoid the inconsistencies which impede the advance of process theory. It both suggests the need for, and offers a means of, reconceptualizing current organization theories. As noted previously, it is unilluminating to explain organization in terms of characteristics of the environment, or in terms of decisions by managerial elites, because these are structural elements of the same type as organizations, and are produced by the same act of seeing. Genuine explanation requires juxtaposing different ways of seeing, so that one way can be seen in another. To this end, the autogenetic perspective points the way toward theories of organization based on social-psychological or microsociological descriptions of interactions among individuals.

Despite its differences with conventional theories of organization structure and design, the autogenetic perspective does not negate their important insights. Rather, it provides a means for reconstructing these theories in process terms. Structure is not explained in terms of a metaphor of adaptation, but in terms of one kind of structure revealing another—i.e., by juxtaposition of deep structure, elemental structure, and observed structure. For example, whereas a theory of strategic choice might correlate decisions made by elite managers with actual organization forms, a model of autogenesis might refer to a sequence of actions and interactions whereby such decisions precipitate a change in form. Such a model would show how top managers, as actors in an autogenetic model, changed their behaviors, and because of their high level of influence were thereby capable (or not) of altering the pattern of interactions among all other actors. The contribution of such a model would be in the development of a set of rules that described how organizational actors are influenced by managerial behaviors to produce changes in the overall patterning of behavior in the organization.

The autogenetic perspective thus promises to provide the substantiating detail necessary to make sense of assertions that organizations adapt to their environments, or that they are designed by rational decision makers. The autogenetic perspective shows how these sorts of relations come to be. Organization theory could thereby give up empirically empty achievement verbs such as environmental selection and strategic choice, which would no longer be needed to shoulder the burden of explanation.

Another advantage of the autogenetic perspective is that it can explain organization even under disorderly conditions that are far from equilibrium. As Prigogine and his colleagues have demonstrated, autogenesis can occur wherever entities interact. Order can emerge even amidst apparent chaos. This is in marked contrast to the traditional metaphor of the organization adapting to its environment which presupposes an existing organization and environment that are near equilibrium. This metaphor cannot explain how organization comes about in the first place. Indeed, the autogenetic perspective offers a powerful insight into the often remarked-upon fit between organizations and environments. The purposeful and efficient nature of complex organizations has always suggested the presence of some sort of intelligence in the design process. In the past this intelligence has been attributed either to an omnipotent manager that chooses the best design, or to a efficient market that selects for it (indeed, part of the appeal of endogenetic and exogenetic theories of organization is that they locate a source for this intelligence). In contrast, the autogenetic perspective views this intelligence more broadly, not as an attribute of a person or environment, but as an aspect or property of the organizing process (see Sandelands and Stablein 1987). This is true of any isolated rule-based generative system. Such systems can always be interpreted in terms of 'organisms' adapted to their 'environments' (Ashby 1968, p. 115). Intelligence thus is a natural property of dynamical systems.

Understanding the process of organizing requires that we describe the actions and reactions of members of the organization. Most organization theories that purport to address the process of organizing do not specify these actions and reactions. These theories could be recast in terms of the general autogenetic perspective presented in this paper, and indeed must be recast if process is to be understood.

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