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A Dissipative Structure Model of Organization Transformation

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Modern organizations must transform amidst the internal and external complexity and turbulence they face. Transformation processes are not understandable through the equilibrium models we most often use to describe system dynamics. More applicable system models, recently emerging within the physical sciences, incorporate disorder, uncertainty, and complexity and provide insight into the process of transformation, its characteristics and dynamics. One such model put forth by the Belgian physicist, Ilya Prigogine, is offered here as an explanatory theory of organization transformation. The model postulates that "inherent stabilities" make more probable a system's successful transition through highly unstable conditions. These same stabilities offer a point of convergence of current theories of organizational learning, of self-organizing systems, and of high performance teams. Summary propositions and some directions for future research are discussed.

INTRODUCTION

Organization theorists and practitioners generally agree that deterministic models of organizational processes, though perhaps useful at times within certain parameters, are not particularly helpful in explaining the complex dynamics of open and interactive organizational systems. The classical, deterministic model, within which a single cause (*A*) results in a single effect (*B*), has given way to a much broader perspective, one in which

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many interrelated variables are considered simultaneously as components of an open system (Miller & Rice, 1967).

Yet, even the open system models have had limited applications to social system processes. As Lundberg (1980) notes, while such models could provide social science with the newer and more comprehensive paradigms emerging in the natural sciences, these models are not adopted more because they often view systems as either mechanical processes or, at best, as equilibrium-seeking organisms. In doing so, the models avoid the dynamics and complexities of social system change and lose relevance in the eyes of theorists or practitioners studying organizational and group system processes.

Lundberg's argument implies that, at best, the study of change from a system point of view has focused on only one type of system change, which might be called incremental or step-by-step change. Such an incremental process refers to the growth or decline in a system with respect to how parts build up or break down, gain in diversity of function, and become intengrated within the system's overall context, all with the purpose of maintaining the system within a certain form or equilibrium parameters.

The purpose of this paper is to draw attention to another type of system change, one in which the entire context of the system is significantly altered. We refer to this change herein as system transformation, implying a profound reformulation of system parts and a total alteration of forms, relationships, and/the processes of maintenance and growth.

This concept of system transformation was perhaps first described in a social system context by Lewin (1951) as a system's change as a whole. At that time, Lewin had noted that the most profound changes in society, and the changes that have had a lasting effect, come via whole system change rather than through step-by-step processes.

In the context of more modern organization theory, this whole system change is a prevalent theme. It is central to the organizational learning models of Arygris and Schon (1978; Argyris, 1982), to Golombiewski, Billingsley, and Yeager's (1975) notion of gamma change within organizational development, to Sheldon's (1980) description of paradigmatic change, Davis's (1982) description of contextual change, and Miller and Friesen's research (1982) on quantum vs. piecemeal change. A common thread among all these modern appraches (and also one prevalent in Lewin's pioneering works) is that such change is most often induced by system jolts, turbulent environmental conditions, or internal conflicts, all of which act as catalysts for the profound transformations that take place.

This paper focuses on the presentation of an emerging general system paradigm that offers promise as a point of synthesis for these various theories of the transformation system process in social systems. The particular paradigm employed is drawn from the theory of dissipative structures, first developed within the fields of physics and biochemistry (Prigogine & Nicolis, 1977; Prigogine, 1980) and subsequently developed as a general model with potential applicability across many system levels (Jantsch, 1981). Because the particular paradigm does consider change as a whole and system behavior within highly disequilibrating conditions (both internal and external), it appears especially relevant to many organizations that do face turbulent or highly uncertain environmental and internal conditions. In this light, the points within the original dissipative structure paradigm that appear to offer insight into transformative processes of organizations and other social systems will be explored further.

IDENTIFYING APPLICABLE SYSTEM CHANGE MODELS

Jantsch (1980) notes that system change models are of at least three distinct types: (1) deterministic, (2) equilibrium, and (3) dissipative.

The deterministic change model assumes that processes are certain and stable and that behavior in the system is controllable. This might be seen as the assumptive basis on which Newtonian physics and much of classical organization theory was constructed.

The shortcoming of the use of a determinist model, as many scientists have noted, is that the assumptions of the model never exist in real life situations (and, in fact, cannot always be created within a scientific laboratory), because absolute control and measurement of all crucial variables is nearly always impossible. Using point-in-time measurement, this model offers not only limited generalizability, but provides very little explanation of how and why any types of change occur in a system.

The second model describes the equilibrium change processes, and is most often applied to describing the open system and its ability to adapt. As Jantsch notes, while this model does begin to account for complexity and interdependency among components, it is applicable only to systems operating within certain parameters and does not describe the transformation which involves profound change system and self-renewal beyond these parameters.

The third perspective, termed here as the dissipative structure model, describes a transition that happens when internal or external conditions of a system are turbulent enough to push it out of the limited parameters where it was able to maintain equilibrium. When these conditions occur, the system may either dissipate amidst disorder or attain a more complex and appropriate alignment, a new ordering far from its initial equilibrium.

The description of the dynamics of the dissipative structure was the basis for awarding the Nobel Prize in Chemistry to Ilya Prigogine in 1977. Prigogine sees that the dissipative self-organizing process is the driving force behind the evolution of all systems, even though it may be a statistically rare occurrence (Prigogine, Nicolis, & Babloyantz, 1972). Aside from experiencing turbulence beyond a threshold, the system that successfully becomes a dissipative structure must also be open to change, must be able to break down old system functions and generate new ones, and must possess certain inherent stabilities that will assist in the reformulation process. These characteristics make possible the necessary coherent behavior that a system must engage in, if it is to survive the intense transition taking place in its evolutionary escape to a new order.

ELEMENTS OF SYSTEM TRANSFORMATION

The transformation of a system within the dissipative process involves complex and simultaneous interactions. A great variety of possible forms can emerge from such a process, and even estimating the probabilities as to which of these forms can be resilient within a certain environment (and which will be less appropriate and more likely to become entropic) would be difficult. Yet, there does appear to be certain characteristics that are essential for a system to become and maintain itself as a dissipative structure. In looking at these, some insight into the necessary conditions for a system's survival within a turbulent and rapidly changing environment can be deduced.

Disequilibrium

The first characteristic, disequilibrium, is the catalyst for transformation in the dissipative structure. The disequilibrium may be a result of both internal or external forces. Sufficient disequilibrium is necessary to create the degrees of freedom within which the system's change can take place. Golembiewski et al. (1975) notes that sometimes it only takes a small jolt to push a system over a threshold into disequilibrium; depending upon the system's initial state, either a "straw that broke the camel's back," or a very major fluctuation may be necessary to create the necessary disequilibrium.

Disequilibrium to a sufficient degree for transformation is experienced by many systems, yet most often highly developed systems have [illegible] mechanisms to dampen change and restabilize equilibrium. [illegible] restabilizing appears almost as a natural tendency, it can [illegible] dysfunctional. In the long term, when a system is [illegible]

the environment is changing, the system becomes increasingly misaligned with respect to that environment. The greater the misalignment with the environment, the less it can depend upon the environment for the energy it needs to renew itself. Consequently, it undergoes an entropy process, wherein its mechanisms deteriorate and the key elements of survival become inaccessible or randomly dispersed. It is this state that has been termed as entropy and recently been seen as applicable not only to mechanical systems but also to biological, economic, and societal systems (Georgescu-Roegen, 1976; Rifkin, 1980).

Symmetry Breaking

Symmetry breaking refers to the breaking down of existing functional relationships, patterns of interactions or system habits that have previously been the source of equilibrium for the system. This symmetry breaking becomes crucial when the forces that normally dampen change are not wholly effective and the systems needs to make a transition into a new structure. To complete this transition, something analogous to Lewin's (1947) idea of system unfreezing must take place. In this unfreezing, the system may both allow and pursue the symmetry-breaking process. In biological systems, this symmetry-breaking capability has made possible the molecular arrangements within carbon molecules that support life forms (Eigen & Winkler, 1981).

Experimentation

Because the dissipative structure is going through an unfreezing process, it is crucial that some mechanism be in operation that will generate new forms or configurations around which the system can reorganize. Bronowski (1970) has noted that it is the ability of a system to produce variants or to reproduce what appear to be errors, that allows the system to generate a sufficient variety of new forms. These particular forms, viewed at a certain point in time, may appear as wholly inappropriate for a system. Yet, one or more of these errors, if retained, can become a new preferred configuration around which the system can reorganize in a new environmental context. As Ashby (1956) has noted, the generating of novelty or variation will ultimately be the system's best tool for dealing with a highly variable and uncertain environment.

The DNA molecule is an example of a system element that preserves a history of experiments by an organism for possible future use. The DNA carries forward recessive characteristics that have no apparent or immediate usefulness in the life of one organism, but may become crucial for survival of future progeny under different life conditions.

Reformulation

The experimenting process results in a repertoire of possible new configurations. The final element of the dissipative process is the selection of a new configuration or organizing principle around which the system may reformulate, and the actual reformulation process itself. While this selection is taking place, the system's experimental activities must take precedence rather than remain as tangential system behavior. The system must try out new configurations until it finds one (or some combination) that will become preferred. The preferred configuration of a successful dissipative structure will be one that is optimizing with respect to making possible a high degree of energy throughput, and an openness or communicativeness to other systems within its environment. The degree of development of the new preferred configuration will also be consistent with the system's prior history and present state of evolution (at least in physical or biological systems) thereby insuring that the restructuring process brings a more evolved (or integrated) system rather than simply a random rearrangement of parts (Waddington, 1975).

The change in the dissipative process from one state to another appears to be an orchestrated, simultaneous leap. The whole system reorganizes around a new preferred configuration, and this implies that the system parts become attracted to the new configuration. For example, one dissipative structure that is commonly observed in a laboratory situation is the Bénard instability. When certain oils are boiled under proper conditions, a dissipative structure appears on the surface of the oils in the form of highly aligned and intricate hexagonal patterns (or Bénard cells). As temperature and other conditions change, the system makes transitions from one intricate structure to another, all reflecting highly coherent or orchestrated behavior.

While this orchestration appears almost magical, close inspection of the Bénard reaction reveals the critical elements in the formative process. The dissipative system is highly experimental during the moment of its transition, trying out many possible preferred configurations. Appearing fluid, its parts are actually so resonant that each change in condition, both internally and externally, brings what appears to be a simultaneous change as a whole. In its autocatalytic process, change builds upon change and the system makes rapid transitions to a new state. It is the degree of resonance within the system (Laszlo, 1978), among system parts, that acts as a bonding element upon which change can build. This resonance in combination with what appears as an intentional movement toward greater openness to change, are crucial for reformulation around a new configuration.

An Example—The Human Immune System

As an example of perhaps the most developed biological system, the immune system provides a good illustration of the key elements in dissipative change. While itself a relatively stable system, the immune system engages in dissipative processes in order to produce needed antibodies. With respect to disequilibrium, the immune function is based entirely on recognition of molecules that it has not previously encountered and on recognition of other familiar elements it knows will be hostile to the body. Through its elaborate monitoring process, it identifies any antagonistic organisms and sets in motion the process of antibody production. The overall immune system is made more resilient by its ability to retain a memory of the patterns of variants that it encounters, and may use these patterns in the future to combat unique foreign elements. By its experimental nature, the system is able to economize with respect to the patterns it stores and does not need to retain every possible variation. Rather, it will play probabilities, maintaining millions of patterns that would fit with the billions of possible elements that it may encounter (Jerne, 1973).

When the immune system does encounter a foreign element, the entire system's symmetry breaks down. The overall functioning of the system changes considerably, attention being transferred from equilibrium-maintaining processes to the production of an appropriate antibody. By experimentation with possible preferred configurations, an antibody is found that will be potentially effective against the foreign element. This antibody is allowed to escape from its usual reproductive pattern (within which its self-replication is normally suppressed). Through a highly coordinated or coherent system alignment, a large quantity of this antibody is rapidly produced to subdue the hostile element.

SUMMARY

The Emergence of the Dissipative Structure

Figure 1 is a summary diagram of the process of transformative change within a system. The components of the process follows.

1. *Disequilibrium Conditions.* The assumed condition within which change becomes possible is one of turbulence, environmental, and/or internal

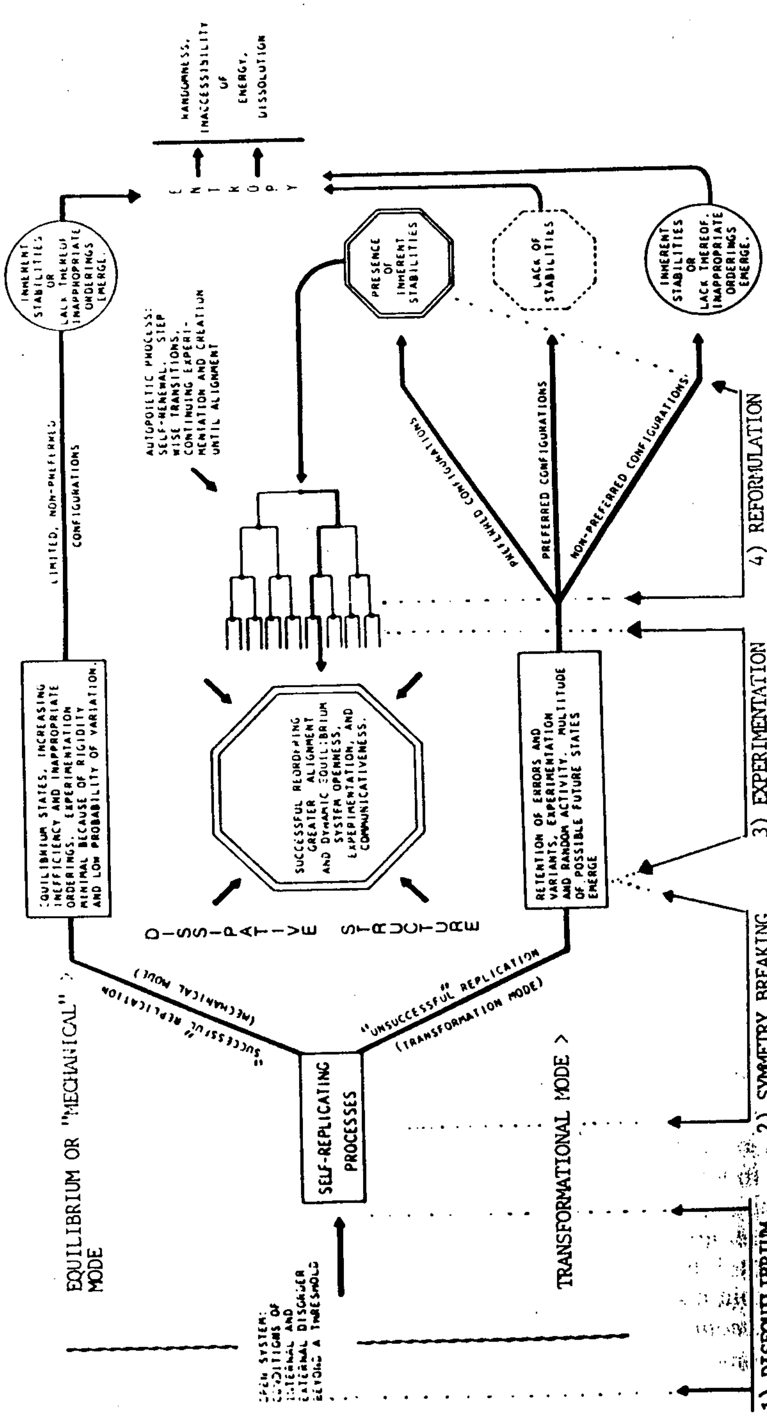

Fig. 4. Four key elements are involved in the dissipative transformation process. Following an initial disequilibrium, the system must break symmetries, experiment to generate new future scenarios, give preference to and reformulate around a new configuration.

2. *Symmetry Breaking*. This implies that the system is somehow breaking down its usual processes. The system's self-replicating or usual autopoetic functioning has become ineffective or has purposely been suppressed in order that new possibilities may emerge. It is at this point where a differentiation can be made between the evolutionary or transformational mode of the system and the mechanical or equilibrium mode. The mechanical mode reflects the case where the system is able to overcome the forces toward change and successfully self-replicate its previous structures and relationships, thereby restoring equilibrium. On the other hand, the transformative mode implies unsuccessful replication, or the ability of the system to break symmetry and further increase the possiblity of change (by increasing the degrees of freedom within which the change can take place).

3. *Experimentation*. Through the experimentation process, the system creates new possible configurations around which it can eventually reformulate. The system that is best able to transform is one in which such experimentation and retention of variants are encouraged, rather than discouraged, dampened, and discharged.

4. *Reformulation Processes*. In this formative process, new configurations are tested within the new environmental constraints and with respect to the system's previous level of development. For this to take place, the system must be highly resonant, both internally and externally, to both its subsystem alignments and its alignments with the contingencies of the environment. The presence of this resonance and the ability of the system to move as a whole into the configurations it experiments with makes successful transformation more probable.

While depicted here two-dimensionally, the entire process might better be seen as a spiral. Once new configurations are spawned, the autopoetic process or continual self-renewal will again build up new structures, much like it does in an equilibrium system. Yet, the difference here is that the course of the system toward entropy has been diverted by the transformative process. In the future, such a dissipative system must continually maintain the elements of the transformative mode if it is to continue dissipating entropy, and if it is to maintain the sufficiently high level of energy throughput necessary for sustaining itself.

CROSS-SYSTEM PARALLELS: THE EVOLVING ORGANIZATION AS A DISSIPATIVE STRUCTURE

With the recognition that research thus far is exploratory and highly inferential, and that systematic evaluation is necessary, the following discussion focuses on using the dissipative structure model as a point of synthesis for a number or theories of organization transformation. Our hope is to develop a model by which the elements of the transformation process can be better understood. As Jantsch (1980) has proposed, we entertain the possibility here that this model, drawn from observations within physical sciences, is not simply an analogy, but expresses an implicate ordering of elements and processes that exist across biological, organizational, and social system levels. This notion of an implicate order (Bohm, 1980), if applicable in this case to general system dynamics, would account for the sometimes striking parallels and convergences which emerge (both within organization theory and across scientific disciplines) when theorists attempt to explain and construct models of system transformation processes.

One of the most direct of these parallels is found between the dissipative structure model and the work of Karl Weick (1969, 1977). Weick's writing on organizations are strongly influenced by his insights into evolutionary processes. He demonstrates the need within situations where a great deal of complexity and variability exist for self-designing systems. These are systems where processes unfold rather than follow a predetermined and unchangeable course. For example, he points to the Apollo 3 mission, within which the astronauts went on strike due to frustration and anxiety in the face of what they experienced as an overly and ill-structured situation.

During the Apollo mission, a great deal of difficulty was encountered in the implementation of a storage system. Over 40,000 items had to be accessibly stored within the spacecraft. The NASA system designers labeled each item and, without any participation of astronauts in the process, packed the items away in compartments, using a computer system to track storage information. Not only did the astronauts find the storage procedures to be ineffectively engineered, but the computer system failed and it became extremely difficult to find and keep track of where things were. Weick notes, had the Apollo team been included in the design of the storage process, their experience and their own ways of categorizing would have provided a more optimal storage configuration, as well as a backup system (i.e., the astronauts knowing their own logical processes and idiosyncrasies, in the event the computer system failed).

Weick points to an essential feature of the dissipative structure in his emphasis on play within situations of extreme complexity. It is only through this play, or experimentation, that true self-design emerges. He contends this process to be the patterned voluntary elaboration or complication of process where the pattern is not under the dominant control of the goals (Weick, 1977). The only possibility, he notes, for effectiveness amidst extreme uncertainty, comes from the capacity to combine aspects of behavior that seemingly have no basis for juxtaposition in a traditional framework

based on utilitarian values. This, in the terminology of the dissipative structure, reflects system activity in the evolutionary mode, behavior which has no apparent value as long as the situation remains within the parameters where mechanistic processes are effective. This is the inefficient action that produces the variants around which a system may realign in effective ways through the experimentation process.

The organizational learning model of Chris Argyris (Argyris & Schon, 1978; Argyris, 1982) emphasizes the importance of the evolutionary mode in the process of organization transformation. Argyris notes that organizations based upon culturally programmed strategies emphasize continuity, consistency, and stability in order to maintain the status quo. He sees that, under the surface, there are many instabilities and inconsistencies that can be used as springboards for change. He postulates that change in organizations sometimes occurs along a linear track, but, at other times, it involves the emergence of entirely new processes. When this emergence takes place, it necessitates a redefinition of organization norms and identity, a new configuration. The possibility of the new configuration is an unknown at the time when the organization experiences an array of internal and external disorders, conditions that it is unable to deal with effectively by its accustomed learning and acting patterns.

Argyris adds an important insight into the process of transition, by noting that it is an internal dialectic, a confrontation with points of conflict and inconsistency, which gives a major thrust toward disorder within a system and results in the upending of an ineffective structure. This upending makes possible the emergence of new and more viable norms and maps by which the organization is redefined. Genuine learning and transition require the surfacing of conflict and inconsistencies that have actually become the context within which organizational members have understood and defined their organization and themselves. The uprooting of these involves high risk and exploration of the unfamiliar, a situation where the only possible point of reference, at least at certain crucial moments, is a commitment to undergoing the process and of at least recognizing (sometimes with the help of an interventionist) that a new and viable form is possible. Argyris also sees a key to survival to be the ability to experiment, coupled with the high level of commitment of organization members to the process of transformation.

Kiefer and Senge (1982) provide a model of high-performance, neonate organizations that also parallels the dissipative structure model. They studied organizations that had apparent success with innovative designs, and have summarized the characteristics which they found to be prominent in these organizations. These characteristics included purposefulness and vision, high degrees of internal alignment among organization members, a stress on personal mastery and responsibility, an emphasis on systemic thinking (and corresponding questioning of effectiveness of present system configurations), and the integration of intuitive and rational modes of processing information and making decisions.

The organization that Kiefer and Senge describe is one that has a clear mission, one that experiments and challenges itself. It is able to let go of a system that is working (though ineffectively) even before there is a clear picture of what will replace it. Members of this organization courageously venture into the void of uncertainty. Their only stronghold, in this void, is a sense that a new and more effective system will emerge in the process. This strategy, albeit perceived as chaotic and threatening, makes transformation a reality.

CONCLUSION: PROPOSITIONS FOR EXPLORATION AND DISCUSSION

To further examine the validity and efficacy of the dissipative structure paradigm as a model of organization transformation, we offer some theoretical propositions for future examination. The propositions follow.

Proposition 1

The higher the level of internal and external disorder experienced within an organization, the greater the probability of either transformation or entropy. This proposition asserts that the experience of disorder and disequilibrium is a necessary condition for the development of either transformation or entropy. The proposition does not assert what the critical factors are that differentiate or determine whether a system utilizes the disorder as an opportunity to escape to a new order (transformation) or succumbs to a crisis that leads to self-destruction (entropy).

Proposition 2

Systems that become transformed, in comparison with systems that become entropic, are more likely to actively engage in symmetry breaking, experimenting with new configurations, and reformulation into an evolutionary configuration that reinforces self-renewing or autopoetic processes. Stated somewhat differently, this proposition asserts that for an organization to be successful in transforming itself, it needs to contain norms supportive of experiencing disorder and embracing it as an opportunity to experiment. Such

norms, in conjunction with a high level of bonding and communication between system elements, provide the ground necessary for the emergence of a new alignment of the system (Zeleny and Pierre, 1976). It is the organization that develops high levels of cooperative behavior, that promotes risk-taking, that nurtures the unsettledness of a confrontative, experimental existence, and that realizes the wisdom of dynamic variation, which successfully dissipates entropy.

Proposition 3

The greater the level of awareness of the dissipative process within a system, the greater the probability of transformation rather than entropy. This proposition asserts that the very understanding of the dissipative model can itself be useful to organization members immersed in a transformational process. Simply having this understanding could add inherent stability to an organization, not in the sense of providing a complete map of exactly where the process is going, but at least offering a context within which the inevitable frustrations and inconsistencies of such a process can be viewed. Understanding this context, and having a sense that a new and more evolved form can eventually make sense of what has become momentarily paradoxical, may increase the probability of transformation.

Hopefully, these propositions will stimulate empirical investigations into the dissipative processes embedded in organizational change, toward the end of not only understanding this process but also learning how to more effectively manage it.

Such investigation is fraught with much difficulty. In the course of developing this model and through some helpful reviews by colleagues, some important research questions and some of these difficult issues have come forth and deserve attention.

The first of these addresses the issue of system evolution. Our first tendency was to assume that a dissipative structure emerged as a more complex system, rather than a simpler one. Indeed, we had been calling it a more complex structure as evolutionary theory (Bronowski, 1970) would indicate. Yet, we realize the important distinction (perhaps a contribution that social systems theory has made) between the complexity of a system and the system and the system's ability to deal with complexity. It is this *ability* that evolves in the dissipative structure process, where as the system's actual complexity (from the standpoint of such factors as interrelationship of elements, or number of elements) might increase, decrease, or remain the same. We would note here that the description offered of the characteristics of the dissipative system, that is, its ability to break symmetry, to experiment, and reformulate, are all elements that would increase its ability to deal with greater comof the dissipative structure (Jantsch, 1980) in terms of configurations adopted, dense packing but flexible coupling of elements, and Weick's (1969) observations of the characteristics needed in organizational systems to insure a greater probability of survival in a highly variable environment, i.e., systems with many interlocked but independent elements, subject to few constraints.

The difficulty of researching the dynamics of dissipative change in the social system is a significant issue, mainly because the whole paradigm is based upon probabilistic behavior among many system parts rather than predictable change in one or a few elements. We acknowledge this problem, and note that the methodology needed to explore such issues is not highly developed. There have been initial attempts in the study of such whole system change by Miller and Friesen (1982) and by Golembiewski et al. (1975) utilizing very innovative applications of factor analysis. Further groundwork may be laid by studying the change in the various dissipative structure elements (non-equilibrium conditions, symmetry breaking, experimentation, and reformulation processes) and respective changes in system structures and other key organizational and group level variables.

Finally, another relevant question has to do with the continuity of a system in the process of change. At what point does one differentiate between a dissipative structure as a continuation of an older system rather than as a development of a new system? A very similar issue has been raised with respect to disappearance or failure studies in organizations (Pfeffer, 1982). To avoid a difficult philosophical question, we would propose that initial study of organizations as dissipative structures focus on systems that reorganize using essentially the same elements that were clearly present prior to the dissipative change process.

The focus on organizations that clearly emerge from prior configurations also points to one final consideration. As noted above, the biological or physical organism apparently carries forward a line of development, a certain degree of learning that does not get lost in the dissipative process. Is the same true in social systems? We would propose that the social system can make a choice here, one that does differentiate the change process in human systems from those at other system levels. The social actors appear to have an opportunity to build upon their history or discard it. As Levi-Strauss has suggested (Charbonnier, 1969), evolution within the social system would seem to be heightened by a system's ability to carry history forward, recognizing such history as valuable learning rather than as a past best forgotten.

REFERENCES

ARGYRIS, C. *Reasoning, learning, and action.* San Francisco: Jossey-Bass Publishing, 1982.

ARGYRIS, C., & SCHON, D. *Organizational learning: A theory of action perspective.* Reading, Massachusetts: Addison-Wesley Publishing Co., 1978.

ASHBY, R. *Introduction to cybernetics.* New York: Wiley, 1956.

BOHM, D. *Wholeness and the implicate order.* London: Routledge and K. Paul, 1980.

BRONOWSKI, J. New conepts in the evolution of complexity. *Synthese,* 1970, *21,* 228-246.

CHARBONNIER, G. *Conversations with Claude Levi-Strauss.* London: Jonathan Cape, 1969.

DAVIS, S. Transforming organizations: The key to strategy is context. *Organizational Dynamics,* 1982, *10,* 64-80.

EIGEN, M., & WINKLER, R. *Laws of the game.* New York: Harper Colophon, 1981.

GEORGESCU-ROEGEN, N. *Energy and economic myths.* New York: Pergamon Press, 1976.

GOLEMBIEWSKI, R., BILLINGSLEY, K., & YEAGER, S. Measuring change and resistance in human affairs: Types of change generated by OD designs. *Journal of Applied Behavior Science,* 1975, *12,* 133-157.

JANTSCH, E. *The self-organizing universe.* New York: Pergamon Press, 1980.

JANTSCH, E. *The evolutionary vision.* Boulder, Colorado: Westview Press, 1981.

JANTSCH, E. *The immune system. Scientific American,* 1973, *229,* 52-60.

KIEFER, C., & SENGE, P. *Metanoic organizations: New experiments in organizational design.* Box 2008, Framingham, Massachusetts: Innovation Association, 1982.

LASZLO, E. *The inner limits of mankind.* New York: Pergamon Press, 1978.

LEWIN, K. Frontiers in group dynamics. *Human Relations,* 1947, *1,* 2-38.

LEWIN, K. *Field theory in social science.* New York: Harper and Row, 1951.

LUNDBERG, C. In T. G. Cummings, (Ed.), *Systems theory for organizational development.* Chichester: Wiley, 1980.

MILLER, D., & FRIESEN, P. Structural change and performance: Quantum vs. piecemeal-incremental approaches. *Academy of Management Journal,* 1982, *25,*(4), 867-892.

MILLER, E., & RICE, A. *Systems of organization.* London: Tavistock, 1967.

PFEFFER, J. *Organizations and organization theory.* New York: Pitman, 1982.

PRIGOGINE, I. *From being to becoming – time and complexity in the physical sciences.* San Francisco: W.H. Freeman and Sons, 1980.

PRIGOGINE, I., & NICOLIS, G. *Self organization in non-equilibrium systems.* New York: Wiley, 1977.

PRIGOGINE, I., NICOLIS, G., & BABLOYANTZ, A. Thermodynamics of evolution. *Physics Today,* 1972, *25,* 23-28.

RIFKIN, J. *Entropy.* New York: Viking Press, 1980.

SHELDON, A. Organizational paradigms: A theory of organizational change. *Organizational Dynamics,* 1980, *8,* 61-80.

WADDINGTON, C. *The evolution of an evolutionist.* Edinburgh: Edinburgh University Press, 1975.

WEICK, K. *The social psychology of organizing.* Reading, Massachusetts: Addison Wesley, 1969.

WEICK, K. Organization design: Organizations as self-designing systems. *Organizational Dynamics.* Autumn 1977, 31-46.

ZELENY, M., & PIERRE, N. Simulation of self-renewing systems. In E. Jantsch, & C. Waddington (Eds.), *Evolution and consciousness.* Reading, Massachusetts: Addison Wesley, 1976.

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