

# Environment and Complexity of Organizations

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Interaction among and unification of people are the very agents that create an organization. An organization can only exist if it exchanges individuals, information, or material resources with the environment permanently surrounding it. Many organizational scientists have recognized that the environment plays a significant but not absolute role in the origin and evolution of organizations (see, e.g., Lawrence & Lorsch, 1967; Meyer & Scott, 1983; Pfeffer & Salanick, 1978). Although every organization continually feels the influence of the environment, it can preserve integrity (invariability of behavior) through four natural operators:

1. *Organizations arise in certain environments.* Organizations themselves are built of individuals, who each live in particular environments. Organizations with such environmental origins bear the behavioral imprints of the surrounding coordinates.
2. *Each organization is independent of the environment.* Organizations' elements (individuals) inherently want to undertake joint actions that help to separate them and each other from the surrounding environment. The organization can only afford to extract necessary information and resources from the environment so long as its independent stance and basis are unchanged and preserved.
3. *Each organization counteracts the environment.* Organizations can preserve independence by ignoring the environment's influences. The very act of organization provides mechanisms for counteracting changes in the environment, by way of stabilizing structure and inten

sifying adaptation of functions (others may call this institutionalization—Powell & DiMaggio, 1991; Scott, 1991). 4 Each organization exchanges information with the environment.

Owing to these natural qualities, organizations can counteract the environment and at the same time adapt to it during the organizational life cycle.

## COUNTERACTING THE ENVIRONMENT

The environment surrounding any organization incessantly changes under the influence of economic, production, demographic, natural, and political processes that take place in the human community. Contrary to the proclamations of many business pundits, the particular influences of “the environment” on any particular organization are accidental and frequently unpredictable. The many separate individual external influences can even oppose each other to generate contradictory situations.

Organizations require some success in counteracting the environment, keeping their own rules and deflecting any encroachments, if they are to maintain their integrity. For example, any organization has the capability to hinder penetration by individuals with undesirable information signals and to let in only those that are necessary for the work of the organization itself. Such behavior outwardly can appear to be a display of organizational conservatism or an aspiration to have a pure invariability of inner order. Organizations counteracting the influence of their surroundings can, when necessary, change their structure and functions in a regular way. As a rule, these changes canalize four organizational axioms of group activity, which have been formulated by traditional organizational science (Rybakov, 1997: 63-5):

1. An organizational pyramid must have a minimum quantity of possible echelons.
2. The actual control range for the leader must be within the limits of potential significance of the control range.
3. The efficiency of the organization depends on passing information efficiently through structural links.
4. Forming subsets of smaller elements of the organization must be done in such a way that destruction of the steady information links between the elements is at a minimum and the majority of all information interactions remain within the newly cast partial elements.

The first axiom is the consequence of the fact that a hierarchy is the initial form for the overwhelming majority of organizations (Simon, 1965). It has been so for hundreds of years, although the manner of human interaction and the composition of organizations' environmental surroundings change incessantly (Bar-Yam, 1997). When there is a hierarchical structure the coordinating and information processes in which both individuals and related groups participate are "hard wired" (or relatively inflexible) and are firmly connected in cycles of interaction one with another. Therefore, any attempt to create a penetrating influence on these processes—either from the inner environment of the organization or from the environment as a whole—is fraught with difficulties. If the inclusion of the new elements results in the collapse of the primary form of organization then the basic structure clusters, which immediately begins to repair the damage.

In accordance with the first axiom, the organization must consist of a minimum possible (for concrete conditions) quantity of structural links and echelons. Communication demands create this rule. Any organization trying to have a broader system of coordination and control must contend with multiple data losses. Up to 10 percent of primary information is lost or distorted due to communication between organizational echelons (Gordon, 1980). When the number of echelons is minimized, the information path from leader to performer and back shortens. This fosters quick execution of decisions and allows the top leaders to be better informed about the real business situation.

As a result, the structure and clustering of the organization give it a gain in stability relative to external disturbances. Management's communication expenditure also goes down. Experienced leaders have given preference to a low administrative pyramid. Small-level organizations can more efficiently adjust to changing conditions than can those with a multi-level structure (Bar-Yam, 1997). However, it should be noted that lowering the height of the organizational pyramid is limited by the potential control range (the second axiom). That control range can be defined as the number of the subordinates whom a leader can manage effectively. When the quantity of an organization's structural links is constant, then a reduction in echelons causes an increase in the actual control range, and the addition of echelons diminishes it.

Research on organizational structures from diverse activity spheres shows that considerable differences exist regarding the significance of control ranges (see Graicunas, 1937; Hammond, 1990; Heimann, 1993; Urwick, 1956). Bar Yam (1997) refers to the combinations of axioms one and two as the complexity profile and amends Ross Ashby's law of requisite variety to suggest that there is a law of requisite complexity profiles.

The significance of the third and fourth axioms is conditioned by the basic volume of data that needs to be taken into account in the organization. Data passes through information linkages, which arise as a result of a functional division of labor and cooperative action between personnel. Strassmann (1985) suggests that more than 75 percent of the time of a contemporary manager is expended on transmitting information to other leaders in a given firm's inner circle. Such wasted time ("time losses") is pre-destined by the necessity of collaboration between the leaders of structural links. Time losses and the necessity of communication account for the de-synchronization of decision processes and the continued violation of cooperative action norms, which themselves lead to the loss of an organization's identity and integrity properties.

If an organizational structure is built in accordance with the third and fourth axioms, the organization will contain minimal quantities of information to be communicated and, in general, will be simpler. Such simplicity is advantageous for some organizational conditions. For example, simplicity creates more favorable conditions to carry out cooperative action. Such simplicity can be achieved via norms, environment, structure, hierarchy, or personality—but it is the simplicity that is the enabler of cooperative force.

Those organizations that have created their own behavioral rules and followed the above organizational axioms have also created the means of security from unforeseen accidental or intentional influences from their surroundings. An organization possesses its own work rules and by following them can successfully make up for negative influences of external factors. For instance, many bureaucratic organizations have existed for a long time before they collapse. Here, not infrequently, they deviate far from the declared primary aims and tasks of both organization and environment, successfully counteracting all kinds of attempts from internal and external surroundings to liquidate them.

## **ADAPTATION TO THE ENVIRONMENT**

An organization's adaptability is its ability to modify itself or its surroundings, and to tolerate what may seem to be an unfavorable change in order to compensate for a loss in efficiency (Ackoff & Emery, 1972). Because of adaptability, organizations can exist for a long time without collapsing in various dynamic surroundings. The potential for adaptability to the influences of surroundings is a natural property of organizations and is conditioned by the following factors:

1. All organizations consist of purposeful elements (the individual) of the same type and these elements have the potential to choose action methods depending on real situations (each real situation can, for this purpose, be viewed as an aggregate of conditions of organization and environment at any given moment) In this sense, very big and complex organizations such as international corporations and smaller ones such as town libraries are alike.
2. Organizations (i.e., the entities) and their various forms do not arise by chance. The elements included in the organization act or react in accordance with their primary structure, but only after carrying out specific verification that some "purpose" might be achieved. (Nevertheless, it is possible that such verification occurred in the past and gets neglected for the existing set of circumstances.)
3. The environment of the organization is the result of an evolutionary process.
4. All organizations are in a permanent state of exchange with the environment regarding products, information, and individuals. Neither static surroundings nor static organizations exist.
5. Viable organizations have elements that recognize the social, economic, political, resource-based, natural, information-related, and psychological factors of both the environment as a whole and of the inner surroundings of each such element within the organization. These elements serve a valued role as "receptors." They not only reveal the appropriate signals, but also, very importantly, estimate them. Information that is the result of such estimates does not remain at the level of receptors and is transmitted to other elements and parts of the organization.
6. All organizations must react to changes taking place in the environment. However, the reaction of any particular organization or elements therein does not always conform to the "real" situation. The changes do not have to be "bad" or "good," "advantageous" or "disadvantageous." They merely drive an organization to a condition different from the former state. In one case it leads to more accord with the environment, in another it stimulates an opposite situation. Therefore an organization does not always react to these changes as a whole, and a reaction can arise from the action of only one or a few organizational elements, which evolve independently.
7. The organization, owing to its structure and capacity for inner transmission of information, has the potential to react to changing environmental conditions.

The organization's reaction to changes in the environment or inner surroundings seldom arises immediately. The speed of adaptation depends on the conditions created for implementing cooperative action or realizing an emergency. This dependence is itself the result of prior cooperative action. On the one hand, cooperative action strengthens counteraction to the environment because it unites the administrative and productive activities of the diverse organizational elements to achieve the general aims of the organization. On the other hand, it slows the reaction of any organization to its external influences. Time is lost for preparing and arranging control operations because of the need to make coherence out of the variety of project influences, diverse specialists, and managers. This negatively influences the quality of decision making, since time is a paramount factor in the contemporary dynamic world. The overdue decision lowers the synergy effect of cooperative action. Moreover, it frequently entails irreparable resource losses, and sometimes has a negative effect on the control process.

Decreasing the productive time lost in the course of cooperative action may be assisted by forming an organizational structure that itself provides a minimal complexity of organizational communications. Use of up-to-date information and telecommunication technologies further lowers the loss.

It has been observed that ineffective work by organizations often is the consequence of the behavior of personnel, not of external influences. The behavior of individuals depends greatly on their individual qualities (temper, education, upbringing, religion, etc.). Clearly, the state of an organization and its surroundings partly influences individual behavior. The inner surroundings of any organization are as dynamic as its environment. Equilibrium arises in an organization when the formalism of inner rules and the possibility of adaptation to the environment coincide (Menard, 1996: 52).

## **COMPLEXITY OF THE ORGANIZATION**

The study of organizational complexity should distinguish the objective from the subjective complexity. The objective or primary complexity results from the self-organization of individuals for joint activity. It is conditioned by the complexity of the environment and the particular environmental influence on the individuals, as well as by the subject matter of tasks that they have solved. This is the objective complexity that arises under the action of the external psychological and inner organizational imprint (Rybakov, 1999: 46-7).

An external psychological imprint forms under the influence of people's psychological features (thirst for leadership and power, avidity, aggressiveness, sexuality, altruism, collectivism). The culture, traditions, religion, and other features of human

interactions arising from group activity influence it as well. The presence of many of the same primary structural elements and clusters across organizations results from the strong influence of such psychological factors in the environment as a whole. That is to say, any organization consists of members of a limited set of structural elements and clusters. Henry Mintzberg (1983) has noted that every organization describes itself "by constancy of parts, which form of it."

The inner organizational imprint canalizes the forming of structure. Under its influence, the typical elements are species and objects of activity; dimension of organization (number of personnel); technology of basic activity (routine, engineering, craft, and creative); accepted strategy and method of management (full hierarchy, control over basic resources, networking, etc.).

A subjective complexity results from the organization or reorganization of group activity. It is the consequence of the erroneous acts that are carried out in a vain attempt to increase the efficiency of an organization's work. Or else it is the result of the acts of individuals who are motivated by a desire for personal benefit. A subjective complexity usually manifests itself in a surplus of echelons, structural links, and organizational communication. It is conducive to worsening the conditions for cooperative work.

As a rule, organizations begin life with a comparatively simple structure and behavior. After a while, during the "aging" process, the organization's information systems become complicated, the number of elements and hierarchical levels of management increases, the procedures for control and coordination become more complicated. All of these aspects cause decision-making delays and increase the number of formal rules of behavior. They also lower the organization's abilities to react to a change in the environment (Menard, 1996: 136). Therefore the organization counteracts and adapts to the environment not only to correct its behavior and functions, but also to change the composition of its elements (parts) and the interrelations between them. That is to say, organizations reform their internal structures to enhance either complexity or simplicity.

Research into ordinary business practice shows that the complexity of organizational behavior often correlates with the complexity of the organizational structure. By analyzing the complexity of the structure one can form an opinion about the complexity of the organization as a whole. What is the complexity of an organization? It is the number of structural links and management levels that the organization contains, as well as the number of organizational communications or functional interrelations between the staff. In a simple organizational structure, smaller delays arise when passing information. Hence it is quicker to make decisions and enhance the flows of organizing and carrying out cooperative action. As a result, the organization adapts to the environment more quickly. Conversely, the more complex an organizational structure is, the more likely it is to receive distorted signals (information) from its surroundings. Protracted delays often arise when this information passes to the leaders who make the decisions. Obviously, a single separate individual reacts most quickly to influences from the environment.

I have often heard from leaders at different levels in organizations that the complexity of an organization's structure depends directly on the dimensions of the organization and the complexity of its activity. For example, the managers say that if an organizational structure or management system is simple, there will be fewer production units and less diversity. This assertion is not always confirmed in practice. I have analyzed more than 20 Ukrainian chemical, building, and machine-building corporations and shown that the number of managerial links does not significantly depend on the diversity of products and number of plants forming a corporation. So this does not explicitly result in a correlation between the complexity of an organization's management structure and the dimension and complexity of the object of control.

Staff's personal desires have more influence on the complexity of the organization's structure (and consequently on the activities of the organization as a whole) than does the nature of production. Also, some leaders' intentions complicate the organizational structure. They aspire to have higher official status since it confers a higher salary, more comfortable working conditions, and the possibility of satisfying imperial ambitions.

In practice I have often found the existence of excessive structural complexity in non-industrial organizations arising as a result of subjective factors. In theory such excessive complexity is undesirable and must be removed. However, this is a difficult task in practice because there is the problem of evaluating the complexity of the organization and making a comparison with that of the environment. The concept of "environmental complexity" is relative. It relates both to the quantity of influences from the surroundings and their meaning, which frequently are perceived unequally by different individuals. When examining the influence of surroundings one must consider not only expressions of meaning, but also the existence of a lack of resonance between the surroundings and the organization or its sub-components. From synergistic science it is known that if some influence of the surroundings on a system is even slightly resonant, then it can turn out to be more effective than in cases with much stronger influences, but not in coordination with the system's properties (Kurdurov & Malinecky, 1983: 43).

It is very difficult to get a meaningful evaluation of the influence of surroundings on organizations and this problem still needs to be solved. So far only very approximate evaluations can be made of the complexity of an environment compared to the complexity of a related organization. For example, one such evaluation has been expounded in *The Philosophy of the Structures of Organizations* (Rybakov, 1997). In this book a method is described using a computation model for the evaluation of environmental complexity. This was built on the basis of coefficients, or a "power law." The use of such a power law formulation allows for the influence of noise (arising from "disturbances" in an organization) when viewed from a probabilistic evaluation of the influences of information as derived from multiple but specific fixed domains of the environment. These power law coefficients were discovered for middle industrial enterprises *a posteriori*. Probabilistic estimates of these coefficients are a means of modeling the character of the relations between business organizations and their surroundings.

I have empirically compared a measure of the environment's complexity (MEC) with a measure of the organizational structure's complexity (MOC) in order to be able to evaluate the target organization's stability. Through these comparisons I have built a computational model and extended its practical use for management consulting (Rybakov, 1997: 64-87). Bar-Yam's (1997) complexity profile "focuses attention on the scale at which a certain behavior of a system is visible to an observer, or the extent of the impact it can have on its environment." Where the complexity profile counts the number of independent behaviors that are visible at a particular scale and includes all of the behaviors that have impact at larger scales, the MEC and MOC definitions count the potential information flows and disturbances to those flows from within and without an organization. As Bar-Yam (1997) notes:

*When the independence of the components is reduced, scale of behavior is increased. To make a large collective behavior, the individual parts that make up this behavior must be correlated and not independent. This reduction of independence means that describing the collective behavior includes part or all of the behavior of the parts and therefore our description of the parts is simpler. When the behaviors of parts are coupled in subgroups, their behavior is manifest at the scale corresponding to the size of the group.*

Within my model, the measure of an organization's stability is expressed as an exponential function. It has maximum magnitude when the MOC and MEC are equal. In this limited case, the disturbances caused by environmental influences provoke responses whereby the organization can absorb those influences owing to proper structure and cooperative action. It can be said that such an organization adapts well to its environment and is situated in a position of "equilibrium." Of course, such equilibrium situations are more theoretical than real. In practice, most organizations effectively act in an environment when the magnitude of the MOC is near that of its MEC (but they are not equal). This circumstance determines the "edge of chaos," using complexity theory terminology (Lissack, 1999). In that position an organization deviates from equilibrium, but not so violently that it begins to collapse because of the influence of the environment. The organization mutates its organizational communications only slightly.

When the magnitude of the MOC differs considerably from the magnitude of the MEC (the magnitude of the measure of organizational stability lies under the bend points on a curve of the exponential function), it shows that an organization, because of its structure, cannot effectively resist the environment or adapt to it. By such structural instability, the organization's functions do not bring about the desired result, since staff cannot fully use its potential capacities for adaptation. The staff are unable to organize cooperative action and achieve the general organizational aims. As a consequence, the interaction of individuals becomes all the more unregulated. After a while, because of growing de-synchronization of work in its elements and parts, the ability of the organization to adapt at all becomes threatened. The organization shifts from the edge of chaos to actual chaos.

Low measures of organizational stability can result from both insufficient and excessive complexity in organizational structure. Insufficient complexity results from the lack of an adequate number of structural elements and functional relations. An organization of this type faces a continual need to compensate for a stream of disturbing influences from the environment by its personnel's actions.

This situation is seldom met in today's organizations; excessive complexity of organizational structure exists more often. In this case instability results from the presence of a large number of coordinating and executive elements, and distant functional relations between them. These excesses create long-term delays in passing information about situations, demanding prompt (and ill-advised) decisions from managers. In addition, when a structure's complexity is excessive, the instability possibly results from the influence of inner processes in the organization. These processes depend a great deal on the morale and interaction of staff. The excessive structural links, when there are not enough functional tasks related to the basic activity of the organization, install their own aims and tasks (different from the aims of the organization), which they implant and deliberately maintain. Such "covert behavior" takes place in spite of the presence of the formal organization's rules of behavior. Excessive complexity provokes both direct emotional and energy expenses for management, as well as conflict situations that complicate or even destroy cooperative work.

## CONCLUSION

On the whole, the problem of understanding and coping with an organization's complexity is a problem of effective cognition and appraisal of the complexity of organizational forms. Practical experiments have confirmed that by evaluating the complexity of organizational structure as regards external information influences, one can form an opinion about the potential adaptive possibilities of different kinds of organizations. Yet organizational structure is only one factor among a great number pre-destining organizational reactions to the influence of the environment. In every organization we have to deal with "human complexity" (McKelvey et al., 1999). An individual is the basic element of an organization, always present to generate some unanticipated behavior within it. Dealing with those unanticipated behaviors is perhaps the greatest challenge now faced by managers and organizational theorists alike.

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