Decision Theory in Complex Systems

By

John Bush

Human beings are continuously making conscious decisions. Life is a stream of decisions made on a continuum from the subconscious to the fully involved conscious state. Many decisions are made "without thinking" as when we have driven our car to a destination and realize that we were not aware of the actions we were taking to maneuver the automobile. Many decisions made during an individual's typical day are made in a distracted state. This process works well until some external event injects itself into the process; for instance, a pedestrian walking out in front of the car. For this reason airplane pilots are constantly admonished to never lapse into a distracted mode while flying their airplane. The consequences of dealing with an injected event can be catastrophic.

A smaller number of decisions made on a daily basis require a higher focus of attention. Should I schedule a dental appointment; what shall I make for dinner; what shall I read; should I call my mother? Decisions such as these require conscious effort, but the consequences of the decision are typically not of great import.

A small number of economic decisions require research, analysis and focused consciousness. The consequences of not deciding well can be severe. Should I buy this house; what stocks and bonds should I purchase; what should be my retirement strategy? The decision process for questions such as these requires rigor. We need to define terms, identify alternatives, devise comparative methods, research and analyze information and data, identify probabilities and risk of consequences, and select a methodology to deal with all these factors. Even after

this rigorous analysis we know there is a chance that our decision will prove to have been wrong and we chalk that up to an unknown element of chance.

It is the latter type of decisions that are the subject matter of decisions theory. The modern discipline of decision theory is approximately one hundred years old. Decision theory attempts to provide a model for individuals and groups to be able to make rational decisions. There are two branches of decision theory: normative and descriptive. Normative decision theory describes how rational decisions should be made; and descriptive decision theory describes what actually happens in the process of making decisions.

Classical decision theory is based on several assumptions. (1) the agents making the decision are rational and are seeking a solution on a rational basis; (2) options which can be chosen actually exist; (3) the process of choosing will be nonrandom; (4) the result of the decision will have an expected utility; that is, it will have value to the decision maker; (5) risk in the process of decision-making is quantifiable; and (6) uncertainty in the process exists when probabilities are unknown.

The elements of the decision process are the decision-making agent, the universe of possible options or alternatives, an assignment of the expected value of each possible option, and an estimation of the risk factor associated with each possible option or alternative. Decision theory uses a wide variety of mathematical and statistical methods to evaluate expected value and risk factors.

In an organization, management is the agent that makes decisions. Once the decision has been made and implemented, systems of review and feedback are put into place to ensure the actions of the organization move toward accomplishment of the chosen solution. Ralph Stacey, in his book *Complexity and Creativity in Organizations* describes this feedback loop: "The second time around the loop, discovery consists of monitoring the actual outcome against the intended outcome expressed in the plan and feeding any deviation between them back into the choice procedure to identify corrective action. Choice and action then consists of choosing

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in carrying out this corrective action. The whole purpose of this technically rational decision-making and this monitoring form of control is to remove surprises, to damp down change and keep an organization moving stably through time according to the joint, prior intention of its members." Thus the process of decision-making changes from rational to one of power and control in the organization.

Many criticisms are leveled against this approach to decision making. No individual organization can claim to be totally rational and ignore the input of preference and emotion in the decision-making process. Possible options and alternatives considered in the decision making process may not represent all the options actually available, especially if the time horizon is far off. The process of assigning expected values to the available options is not as precise as pictured. If the decision time frame is long, expected values may change radically or vanish. Uncertainty in the decision-making process does not represent lack of knowledge, but reflects those elements that are actually unknowable.

Stacey summarizes the heart of the criticisms, "The immediate conclusion drawn is that ignorance can be overcome by greater investment in gathering information, funneling it to some central point or it can be analyzed, and then feeding it back to the actors. The dominant schema therefore leads people to believe that ignorance can be overcome by research into organizational excellence, incompetence can be overcome by training and developing managers, and systems can be used to prevent bad behavior."

The problem with decision theory, as we have described it, is that it is based on a Newtonian clock-like universe and does not accurately describe the universe as it really exists. The science of Complexity Theory provides us with a much better framework to understand the dynamic process of decision-making in organizations.

Decision Making in Complex Organizations

Organizations are complex systems. A system can be considered complex if its agents meet four qualifications: diversity, connection, interdependence, and adaptation. In an organization the agents are all the people who work within the organization. These agents are diverse in that they are individuals with their own unique personalities, experiences, intelligence, emotions, preferences, etc. They are connected with each other by affiliation within the organization for the purpose of achieving the goals of the organization. They are interdependent since the work of each depends upon the other members of the organization. They adapt because each member of the organization is learning, changing, and evolving as a result of his interactions with the other members of the organization.

The process of adaptation is highly dynamic in response to local and global environments. The local environment of an organization is the interactions that occur within the organization; global environments refer to the interactions of the organization itself with other organizations. As organizations are connected and interdependent globally, organizations themselves learn and change and evolve locally, and individual agents within those organizations also adapt. It can be seen that adaption is a highly interconnected dynamic system.

Complex systems are often unpredictable and they can produce large events. They are robust and able to recover from serious damage. Complex systems produce bottom-up emergent phenomena where the results on the macro level are not equal to the micro parts of the organization. This phenomenon of emergence means that not only will the results be larger than the parts, but that at times the results will be different in kind. An example often given is the phenomena of self organization seen in flocks of birds or schools of fish. Emergent phenomena arises bottom-up without any top-down planning.

To understand the process of decision-making in complex organizations we must understand the concept of landscapes. Professor Scott Page in The Teaching

Company course, *Understanding Complexity,* presents a full description of landscapes in complex systems. The idea of the landscape is both a metaphor and a mathematical object wherein the value of a function at a particular point is mapped as an elevation on a landscape. Landscapes are composed of valleys and two kinds of peaks: local and global. A local peak is a point on the landscape from which a step in any direction is a step down in elevation. A global peak is the highest of all the local peaks of a given landscape. In the metaphor a peak represents a high point of value and for organizations, the height of the peak represents the economic success of the organization at that point in time.

Professor Page describes three types of landscapes: Mount Fuji, rugged landscapes and dancing landscapes. A Mount Fuji landscape has only one peak which is both the local and global peak. A rugged landscape has many local peaks and one global peak. This is the case when many organizations are represented in the landscape; the economic value of each of the organizations is a local peak while one organization that surpasses all others is represented by the global peak.

The metaphor of dancing landscapes is important to our discussion of decision-making in complex organizations. Recall that all the organizations represented in the landscape are themselves part of a complex system. They are diverse, connected, interdependent, and adapting. Each of the organizations is in competition with the other organizations in the landscape. As one organization makes decisions that increase its economic value, other organizations in the landscape experience a decrease in value. In our metaphor the local peak of the successful organization increases in height while the local peaks of the other organizations decrease in height. The landscape has changed its configuration and has "danced". The ongoing dynamic of decision-making within all the organizations and the resulting increases and decreases in value results in a dancing landscape.

The paradigm of decision-making in complex systems is radically different from the classical model of decision theory. Complexity theory teaches us that the future is truly unknowable, not just unknown. Stacey writes, "Creative futures emerge

unpredictably from self organizing interactions between members; therefore, they clearly cannot use some forecast of long-term outcomes to decide between one action and another." As previously mentioned, Stacey discusses the assumption in classical decision theory that the future is merely unknown and that by applying more resources to the effort we can discover it. We cannot assign probabilities, future values and risk estimations since we live in a dancing landscape.

Classical decision theory is based on the assumption of rationality; agents act in rational ways in search of solutions that are rationally measured. Complexity theory recognizes the strong dynamic of the entire psychological milieu within the organization. We cannot represent all the elements of decision-making on strictly rational grounds.

Complexity theory teaches us that the goal of stability and uniformity in the organization may be a self-defeating one. Stacey writes, "Organizations are systems that are part of a larger environmental system and that evolve through a process of creative destruction and spontaneous self organization. Such evolving systems are in states of non-equilibrium, and their futures are unpredictable. Disorder is an essential part of the progress of the system. Organizational and environmental systems are so complex that agents within them cannot plan their long-term futures. Those futures emerge or evolve from the interactions between agents."

Complexity theory teaches us about the process of learning, changing, adapting and creating within an organization. Organizations exist on a continuum from highly structured to disordered. In a highly structured organization authority flows down from the roles occupied by the powerful. As a result most members of the organization are left with little individual freedom. The work of the majority of members is to implement actions intended to achieve the outcomes intended by the powerful authorities within the stable organization. However, complexity theory shows us that learning, change, and creativity occur in the disordered state at the

edge of chaos. So as authorities create a more stable and structured organization, they create an environment less likely to produce learning and creativity.

The current nature of management is based on the premise that order in an organization is maintained by strong management and clearly defined and enforced structure. However, the science of complexity shows that order is a bottom-up phenomenon, not top-down. Self-organization is an attribute of complex systems and management need not fear anarchy.

Lessons from Complexity Theory

Leaders of an organization cannot know, anymore than anyone else can, where the organization is going.

The future is uncertain and probabilities and risk factors cannot be measured.

As local and global environments become more complex, landscapes will dance to a faster tune. The pace of evolution and change in organizations that learn to adapt more quickly will prosper and survive.

Large breakthroughs and emerging phenomena will arise in the organization that recognizes itself as a complex system and manages itself accordingly.

The role of management in the organization is both complex and paradoxical. On the one hand management has the responsibility to maintain stability and organization, while at the same time, allowing and fostering the presence of disorganization wherein learning, change, and creativity may flourish.

Ralph Stacey summarizes the role of management. "A complexity theory of organizational development therefore ascribes very important and very difficult roles to management in addition to the currently dominant notions that also continue to be important from an ordinary management perspective. Complexity

theories of management lead to a very rich, paradoxical theory of leadership in which leaders have to be both the conventional directors of others in the far more subtle containers of their anxiety and provokers of their double-loop learning capacity. These different attributes of leadership do not blend harmoniously with each other. Instead, they conflict with each other; directing and intentionally not directing are diametrically opposed ways of behaving and both are required of an effective leader in a complex adaptive system."

Complexity theory does not give us a new, theory du jour of managing and decision making. Rather, it sheds light and allows us to see more deeply into the not-so-neat world of organizational leadership and action.

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