Evolution Perspective: A Guide for Action*

Robert C. Waters
George Washington University

Kenneth E. Boulding was one of the greatest social scientist of the 20th Century. His output was prodigious: over 30 books and 150 papers. His creative synthesis of biology, physics, chemistry, mathematics, economics, sociology, logic, etc. into a universal, open system perspective was a towering intellectual achievement. The implications of his perspective provide many insights into the process of management.

The first section of this paper outlines the evolutionary perspective or system developed by Kenneth Boulding. The second section, based on the first section, draws implications for management. His perspective is most fully described and supported in his major work *Ecodynamics*.[1] However, it is the basis for a number of his other writings.[2] Also, Robert Solo has provided an excellent retrospective of Boulding's work.[3] The evolutionary perspective is basically a biological model that Boulding applies to physical, biological and social development. However, in this review, only the managerial implications of biological and societal evolution have been examined.

BOULDING'S EVOLUTIONARY PERSPECTIVE

Boulding's original field was economics, but he possessed an extraordinarily broad-ranging curiosity. He read and studied widely and became one of the very few who have been able to articulate a convincing, original systems theory of human society. Today, the association of biological evolution with societal evolution by analogy is well established but Boulding's ambition was greater. He went beyond analogy to build a theory that integrated physical,

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* Two reviewers of this paper questioned its relevance to engineering management education and practice. It is an attempt to use advances in evolutionary biology and paleontology, as interpreted by Kenneth Boulding, to provide a framework for examining strategic issues confronted by technical managers. In my view, the subject is relevant.

Another reviewer maintained that my "premise that '… formal strategic planning is probably a poor investment' flies in the face of sound, proven management theory employed throughout the construction industry for the last half century." I was for several years involved in corporate planning at TRW; I know that those results were a waste of money. However, I am unsure that the reviewer and I are discussing the same thing. I would agree that the successful prosecution of any largescale endeavor requires extensive formal planning and coordination, but it also requires on-going adaptation to changing circumstances, as any project manager would testify. The point here is the farther in the future one attempts to determine events, the less likely the desired results.

biological, and societal evolution. His first step was to divide evolution into three stages or 'sagas.'

The three sagas of evolution have been physical-chemical, biological, and societal. Each stage of evolution has resulted from the development of sufficient complexity in the prior stage. The first saga is composed evolution of materials after the Big Bang from the initial hydrogen universe to the development of one containing the building blocks of DNA (oxygen, nitrogen and carbon being added). The second saga contained the development of living organisms, from single cells to human beings. The third saga has encompassed the development of human society, which is based on the human nervous system, but has included all the knowledge that people have learned. This learning is contained in people, organizations and things that people have created.

Although it may be appropriate for the first saga also, in the second and third sagas, evolution has consisted of the accumulation of knowledge or know-how derived from the production or realization process. The process occurs when knowledge from a genotype [i.e. some sort of plan] is combined with materials, energy, space and time to create an improbable phenotype [specie or artifact]. Also, the availability of materials, energy, space and time are subject to change as a result of increasing knowledge.

When biological evolution reached the stage at which the human nervous system existed, the third phase of evolution commenced, societal. In this phase, human biology or instinct has remained essentially stable, but evolution has continued and apparently speeded up through the accumulation of learning. Fundamental to human learning has been the development of language and later writing. With language humans have been able to transfer images from one to another. A result has been the ability to coordinate human activity toward images of the future. With writing, the ability of humans to store and transfer images was exponentially enhanced.

Each phase of evolution introduces new elements into the overall system of change. Thus, there are important differences between biological and societal evolution. The genetic information, which produces biological species, is contained in the organisms themselves. In biological systems, the essential change is in the genetic structure, and it is an unending selection of mutations in the genetic structure contained in the DNA, which constitutes the drive of evolution toward ever-increasing complexity. Selection takes place mainly in the phenotypes – i.e., selection in the chicken, whereas mutation is in the egg. Social mutation is similar. The genetic information, which produces human artifacts, is contained in human beings, human organizations, and material artifacts, which are different from the ones being produced.[4] It also has a genetic structure in the form of human knowledge and its prosthetic devices in the shape of libraries, blueprints, computers, laboratories, and so on. As in biological evolution, knowledge is able to direct energy, to sustain temperatures, and to select, transport and transform chemical elements into improbable structures, not only of skin, blood, and brains, but also of walls, water pipes, and computers.[5]

The Process of Change in the Ecosystem- An ecosystem has innumerable niches for different kinds of creatures and behaviors. A niche is the potential equilibrium population of a phenotype. The basic evolutionary process is the accumulation of knowledge, i.e. changes in genetic structure of phenotypes [species and artifacts]. By genetic structure, Boulding meant any egg, design or plan that contains the instructions for producing a phenotype such as a chicken, university, or building. Since the environment is composed of many niches, some of which are competitive and some of which are complementary, the interaction among them determines the potential size of each. At any point in time or space, there will be an ecosystem, with a given set of parameters that will move to equilibrium where the rate of growth is zero, and all niches are filled. However, equilibrium is never attained because niches open up, and sometimes are filled, sometimes not, depending on the capacity of the system for mutation; each successful mutation opens some niches and closes others. "The pattern jogs along in an immensely complex interaction of things, organizations, and people, with biological, meteorological, and geological environments, structures, and populations." Biological and social evolution consists mainly in filling of empty niches in the course of mutation and selection. Biological mutation comes from changes in the DNA of a species. Societal mutation results from invention, discovery, and other creative activities of humans. Whereas biological changes in the DNA are largely random often stimulated by environmental stress, societal mutations are often intentional efforts of people to create something new. The motive force maybe needs, curiosity or accident. In biological selection, the members of the species that best fit the niche in terms of survival tend to fill the niche, given the environmental conditions. Societal selection is quite similar. People, organization, and things that are desired by society tend to be produced.

Trend Toward Complexity- There is apparently a "time's arrow" in the evolution of biological and social species, which is reflected in change through time from simple to complex and in the development of awareness, consciousness, and intelligence. The suggested explanation of the pattern of increasing complexity of species that is evident is the principle that "there is always room at the top." An ecosystem may just have an unfilled niche for a species just above the level of complexity of those that constitute it. Hence, mutations toward increased complexity, and especially those toward adaptability, are likely to find new niches even in existing systems that seem rather full, and so survive.[6]

Societal Evolution- In *Evolutionary Economics*, Boulding defined evolution as ecological interaction under conditions of constantly changing parameters.[7] As before, the change in parameters is mutation; ecological interaction is selection. He reiterated that both biological and social evolution are processes in genetic structure – i.e., in the structure of information or knowledge, which constitute the potential for the production of the "phenotypes," or products, both biological [for instance, a chicken] and social [for example, an automobile, a corporation, or a computer programmer].

The pattern of human development is seen to be an extension, enlargement, and acceleration of the pattern of biological development through mutation and selection. In both developments, selection is ecological interaction constantly creating new niches and destroying old ones. In selection, the genetic, i.e., knowledge structure, selects those materials toward which it directs its energy and selects the direction of the energy. It is a process of choice and evaluation. In societal development, mutation takes the form of invention, discovery, and expansion of the noosphere and noogenetic structure. The noosphere is the totality of the cognitive, including values, of all human nervous systems, plus the prosthetic devices by which this system is extended and integrated in the form of artifacts such as libraries, computers, telephones, post offices and so on.[8] Noogenetics is the structure within the nervous system, particularly the brain, with which an individual human has to learn. A capacity of the human mind of great importance to decision-making is the ability to form complex images of the future that are a necessary prerequisite to fulfilling them. Boulding asserted that this image-forming capacity has created society, social evolution, and human artifacts, which are the keys to societal evolution.

Human history is characterized by a phenomenon that is unknown in prehuman biological systems: niche expansion through the production of artifacts. Here again, mutation is primarily in the genetic structure of knowledge – new ideas, new skills, and new know-how. Selection again is in the phenotype. An unsuccessful mutation in the genetic structure, whether social or biological, is one, which will not be able to produce a phenotype that has a niche in the total ecosystem. For example, if mutation in know-how, a new idea, produces a commodity for which there is no demand at a price, which will make it worthwhile producing, that commodity will not be produced, or, if it is produced, it will soon disappear from the market. New and successful phenotypes, on the other hand, will change the ecosystem and will change niches of all the old phenotypes. Some of these niches may be eliminated, in which case the phenotype become extinct. This process of the creation of new phenotypes through genetic mutation and the extinction of old phenotypes through the diminution of niches has been going on now, according to Boulding, for two or three billion years. It finally produced the human race and the human race in turn has produced enormous quantities of artifacts, all following the same general principle.[9]

System Indeterminacy- The evolutionary model does provide important insights about the future, e.g. increasing complexity through time; however, it does not lead into easy and secure predictions, and its essential indeterminacy makes prediction impossible. Prediction of the future is possible only in systems that have stable parameters like celestial mechanics. Evolutionary systems by their very nature have unstable parameters. They are disequilibria systems and in such systems the power of prediction, though not zero, is very limited because of the parameters themselves.

IMPLICATIONS FOR TECHNICAL MANAGERS

Economic Development- The evolutionary system provides insight into why the West has dominated the economic development over the last 500-years. Rich individuals, organizations and societies, have had surplus resources. These resources have provided the potential for knowledge expanding activities. During much of human history, most surplus resources were consumed in military expenditures and conspicuous consumption. With the development of decentralization of Europe after the fall of Rome and later of democracy, an increasing proportion of the surplus resources in the West have been directed toward knowledge enhancing activities, which have driven economic development. This has been particularly true in the US. Individual acceptance or support of technical change has been greater than elsewhere. Government support of science, education, and business competition has been greater than in most other societies. Patent protection, venture capital, small business tax incentive, etc. have encouraged inventors and entrepreneurs. A result of these trends is that among the large nations the US remains the wealthiest, and in comparison to the poorest nations, it is widening the gap. The American environment, including its management style, has paid off, and presumably will continue to pay off into the foreseeable future.

In Boulding's model, artifact production is key to increasing the knowledge base on which the advances to the next level of human progress depends. Since technical management is the organizing skill in the production process, its role is pivotal in societal progress. Specifically, the objectives pursued, images conveyed, and resource allocated by managers determines the vitality of their organizations and by extension, society. The model provides holistic view of management role in societal evolution. Implications follow for managerial planning.

Planning- The concepts of change through selection and mutation provide guidance for managers. With selection, management looks for ways to better fit its present niche. This entails concepts such as customer focus, value added product and service offerings, optimum organizational scale, knowledgeable and motivated employees, and continuous learning, especially from failures. It would encourage investments in knowledge such as idea sharing and mentoring, research, team building, education and training, career development, and job rotation. The continuing production and transmission of knowledge, i.e., Knowledge Management, is a key to the effectiveness of the manager's role. New knowledge may be imported or created. To be proactive, management must experiment and learn, and then apply new knowledge. Really new knowledge is only obtained by failure.

In the long run, all given niches fill. For an organization to grow, it must replace its competitors in the existing niche and/or develop or migrate to new niches. The model would encourage mergers and acquisitions in order to strengthen the organizational competitive capabilities and reduce competition in the niche. It would encourage openness and adaptability rather than efficiency. Migration would follow diversification opportunities of scale and scope as suggested by Chandler.[10]

Mutation concerns the expectation of continuous changes in the environment, which may be internally or externally generated; niches are being continually created and destroyed. A too well designed, i.e. efficient, organization without any slack resources does not have the capability to change when external conditions change. This could lead to extinction. The increased number and size of industrial laboratories since WW II, has been one means to address the impact of mutation on firms. The laboratories have served two purposes: They provide [1] a source of new products, processes, and services; and [2] insight into the changing state of knowledge, particularly science, related to the firm.

Boulding pointed out that our ability to predict the future is very limited. "This is inherent in the system itself. This is not to say that the system has no patterns. We can make rough probabilistic predictions of the future, but this is different from the exact predictions of systems, like celestial mechanics, in which the parameters remain constant."[11] This suggests that elaborate planning systems are probably a waste of money; a better approach, along the lines used by Jack Welch at GE, is flexibility and adaptability, based on an informed, open, responsive, coordinated and motivated people in organizations. For example, Jack has been open to acquiring good ideas from any source, even from his wife! Also, efforts need to be expended in developing images of the future opportunities and testing these images in the real world; i.e. experiment and learn from the experiment. Any change in our image of the world, i.e. learning, is the result of failure of predictions or expectations. Since learning is the key to adaptation, the implications of failures must be analyzed and timely and appropriate action taken. The implication of Boulding's model is a strong argument for open communications and the participative style of management. That is, superior organizational performance is potentially available to managers that draw on the creative and intellectual powers as well as the physical capabilities of their co-workers.

CONCLUSIONS

This is an attempt to provide the implications of Kenneth Boulding's theory of societal evolution to a new audience, technical managers. The role of management, although not specifically identified, is key to his perspective of social development. His model provides an integrated perspective on economic and social development and a holistic structure to evaluate many issues in planning, leadership and motivation in relation to societal evolution, especially economic development. In summary, organizational leaders should expect that in time any line of business will saturate the market demand and margins will fall. Fundamentally, there are two potential actions: selection [a short term strategy] and mutation [a longer term strategy]. In selection, the strategy is to attempt to dominate the niche. The model suggests that the most likely successful mutations, i.e. developing new niches, will occur at the top of the ecosystem or the level of most complexity, hence this would be the place to invest. Since knowledge of the future is uncertain, formal strategic planning is probably a poor investment. Planning should emphasize openness to ideas from all sources, and provide the capability to obtain new information and to adapt to it quickly as new ideas emerge that are relevant to the organization

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BIOGRAPHICAL INFORMATION

Robert C. Waters received his degree of Doctor of Business Administration from the University of Southern California. Also, he holds an MBA and a BS in engineering from UCLA. Since 1979, he has been a member of the faculty of the George Washington University as a professor of engineering management, and at various times, department chair. Also, he was on the faculty of the University of Missouri-Rolla, a visitor at UCLA and at Webb Institute, and held management positions at TRW Systems and GE. His interests include evolution of technology and organizations, history of engineering management, and the management, economics, and culture of technical organizations.