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General Systems Theory in Archaeology: A Retrospect

Hiroaki Watanabe

Abstract: Considering the impact of General Systems Theory in archaeology, this paper reviews the exemplary study of Clark and the applications of the theory, its critique and its contributions to Syro-Palestinian archaeology. Clark (1978) made the most detailed discussion of the utilization of systems thinking in archaeological research. The exemplary applications of General Systems Theory are Flannery's study of Mesoamerica and the Hesban excavations in Jordan, known as the Madaba plains project. Despite many efforts of the past decades, General Systems Theory has not realized a general law. Archaeological theory cannot be extracted from General Systems Theory. The systems approach is unable to explain the great richness, variability and specificity of cultural production. Systems theory, however, has contributed to archaeological research in its modeling techniques. The developing of research designs is carried out using the notion that culture is a system composed of subsystems. This concept is based on the General Systems Theory. Regardless of the faults indicated by the critics, General Systems Theory certainly made significant contributions to the history of archaeological research.

Keywords: General Systems Theory Archaeology Systems Equilibrium

1. Introduction

General Systems Theory has become a popular discipline since it was introduced to archaeology in the late 60s. According to a poll of American archaeologists conducted in the 70s, General Systems Theory was ranked third as an area of theoretical and methodological interest among American archaeologists, while cultural ecology was ranked first; the rise of civilization, second; sampling, fourth; and sociocultural evolution, fifth (Schiffer 1978:154). Flannery (1973) characterized the systems approach as one of the important approaches to the new archaeology.

General Systems Theory was first advanced by brilliant thinkers like von-Bertalanffy (1968), emerging during the 60s and 70s. Major aims of General Systems Theory are four-fold: (1) The various sciences have a general tendency towards integration. (2) A general theory of systems appears to be a center of such integration. (3) In order to aim at an exact theory in the non-physical fields of science, such theory may be an important means. (4) The goal of the unity of science will be brought by this theory (von-Bertalanffy 1968:38).

Many articles have been published in which General Systems Theory was explicitly used in archaeological analysis. Binford (1965) proposed that culture be viewed as a system composed of subsystems. Flannery's work about early Mesoamerica (1968) is considered to be a clear landmark statement. Rouse (1972:245) in his Introduction to Prehistory, showed prehistorians' attempts to develop a scientific approach. Zubrow (1975) made a study of long-term population-resource relationships in an ecological framework. A collection of eight papers dealing with archaeological change was presented in Hill (1977). Almost 20 pages were devoted to an analysis of systems theory concepts and archaeological applications in the text book by Hole and Heizer (1977:358-376). Clark (1978), furthermore, made the most detailed discussion of the utilization of systems thinking in archaeological research (Willey and Sabloff 1980:193). In this paper, we will review the exemplary study of Clark, the applications of General Systems Theory, its critique and the contributions to our branch of archaeology, Syro-Palestinian archaeology.

2. The Landmark Work of Clark (1978)

Clark (1978:43) states that the term *system* is taken to embrace any intercommunicating network of attributes or entities forming a complex whole. The concept of an archaeological system has not been fully developed; Clark confesses that we do not yet know what sort of system we are dealing with and that we only know little bits of these archaeological systems' behavior that we can roughly match in other kinds of systems. It is necessary, therefore, to build a model which integrates these bits of knowledge and approaches the total knowledge of archaeological systems (1978:44). Clark, then, takes a look at common properties found in several classes of systems to construct a temporary model as follows.

2.1 Feedback

Feedback is the case in which the attribute values are connected and a change in either one may result in a corresponding transformation in the value of the other. A feedback subsystem is indicated by a two-way arrow in a systems diagram. Feedback is important to bring systems up to, or away from, states of equilibrium or stability (1978:47).

2.2 Equilibrium or Stability

(1) A system is in stable equilibrium if it always returns to its current state after experiencing small displacements from the state. (2) A system is in unstable equilibrium if small displacements cause it to move towards some alternative and fresh displacement from the equilibrium state. (3) A system is in metastable (semi-stable) equilibrium if it is stable without a catalyst, but with the catalyst it initiates displacement away from the equilibrium state. (4) A system is in steady state equilibrium if its state is kept stable only by certain constantly maintained variables, attribute states, or values. (5) A system is in dynamic equilibrium if its components closely approximate to a stable state despite the continuously changing values of its components. (6) A system is in statistical equilibrium if, according to certain probabilities, the frequency of occurrence of the component populations continues to remain proportionately. (7) A system is in an equilibrium basin, area, or set if under a certain set of conditions the transformations of these values continue to remain within a limited set constituting the 'basin' or stable region (1978:45-50).

2.3 Goal-seeking or Homeostasis

It seems that many kinds of system may have the capacity for searching-out and concentrating on desirable goals or states. Homeostasis, characteristic of complex systems, is system running towards equilibrium states (1978:51). The classic examples of homeostatic systems are temperature-controlling mechanisms in mammals. Thermostats of machines have the same function (Hole and Hetzer

1977:359).

2.4 Regulation and Control

Certain kinds of complex system have the capacity to conduct self-control by self-regulation. Regulating and controlling subsystems of this kind have the important capacity to act as a medium between the system and its environment or context. The extreme range of external fluctuations will be blocked and filtered by the regulator (Clark 1978:52-53).

2.5 Limits and Networks

There are limits which constrain the variety of states of an attribute or system. Systems can be seen as interlinked networks of attributes forming a complex whole. One example is an archaeologist who may appear on television because the act fulfills the personal systems to earn money and so forth (Clark 1978:55-56).

2.6 Adaptation and Directive Correlation

Adaptation occurs when a change in an environment system is connected with accompanying changes in a coupled culture system. The systems usually have past, present and future conditions. A certain limited set of attributes at the time of adaptation is called directive correlation towards future condition (Clark 1978:57-58).

2.7 Problem of 'Black Box'

When the researcher confronts a complex system, totally concealed except an input terminal and an output terminal, the problem of a 'Black Box' arises. Observation of the changing relationships between varying values at the input and output terminals is the only information available about the system within the box (Clark 1978:59-60).

2.8 Game Theory

Supposing there are variables of a, b, c, d, e, f, g, and (a, b, c, d) can become any of seven variables but (e, f, g) can only become e, f, g, respectively, all examples of a, b, c, d would eventually yield systems composed entirely of combinations of e, f, and g. This transformation of system (a, b, c, d) into another, (e, f, g) can be the example of game theory (Clark 1978:67-68).

3. Applications of General Systems Theory

The above mentioned concepts have been applied to archaeology since the late 60s, and two of such applications are worth mentioning here: Flannery's study of Mesoamerica and the Madaba plains project in Jordan, also known as the Hesban excavations.

3.1 Flannery (1968)'s study of Mesoamerica

Flannery (1968), in his study of Mesoamerica, viewed man and the southern highlands of Mexico as a single complex system. The system consists of many sub-systems of mutual influence between 8000 B.C.E. and 200 B.C.E. Flannery's work includes the study of regulatory mechanisms and negative feedback processes that promote equilibrium and counteract displacement from the stable condition over long periods of time. Positive feedback processes are also studied that amplify deviations, causing systems to expand and reach stability at higher levels (1968:68).

3.1.1 8000~2000 B.C.E.

This period is the preceramic era of hunting and gathering. Flannery describes two procurement systems: plants and mammals. The plant procurement system has three sub-systems: Maguey, Cactus Fruit, and Tree Legume Procurement. The mammal system has two: White-Tailed Deer, and Cottontail Rabbits procurement (1968:69-73).

There are two regulatory mechanisms: seasonality and scheduling. Seasonality means that natural resources are seasonally-restricted and that by this effective counteraction against population increase, groups cannot remain large all year. Scheduling is the solution for the problem that there are times of the year when a number of resources are available simultaneously, producing a situation in which there is some conflict for the time and labor of the group (Flannery 1968:74-

78).

One common activity of the food collecting period was the harvesting of annual grasses. Flannery describes this as another system, Wild Grass procurement. With accidental deviations in the system, a positive feedback of maize cultivation was established and eventually became the most profitable single subsistence activity in Mesoamerica. The system grew steadily at the expense of all other procurement systems in the highlands (Flannery 1968:79-81).

3.1.2 1500~200 B.C.E.

In this period, concentration on maize production made it necessary to re-schedule other procurement systems. Maize could be grown year-round in some regions, but only during the rainy season in other regions. Certain seasonal activities were abandoned in regions of year-round agriculture. The dry season was left open for intensive seasonal collecting activities in regions of rainy season farming (Flannery 1968:81-82).

Deer Hunting and Wild Water Fowl procurement were re-scheduled. The best season for deer hunting in the oak woodlands of highland Mesoamerica is late Fall, after the harvest of maize crop. This resulted in intensive deer hunts during fall and winter. However, peoples in lowlands had year-round resources; deer hunting had to be re-scheduled so as not to take manpower. Most ducks in Mesoamerica are available for procurment only between November and March. Flannery suggests that in areas where agriculture was practiced year-round, exploitation of winter ducks would have conflicted with farming. In areas where winter frosts prevent agriculture, ducks could be heavily exploited (Flannery 1968:82-85).

Flannery, in conclusion, states that the approach in his study does not attribute cultural evolution to discoveries, inventions, experiments or genius, but enables us to treat prehistoric cultures as systems (Flannery 1968:85). Plog (1975:214) remarked that this approach had added both more detail and more insight to our understanding and that we know a great deal more about Mesoamerican subsistence practices than prior to Flannery's analysis.

3.2 Madaba Plains Project, Hesban excavations in Jordan

The excavations at Tel Hesban in Jordan were carried out initially under the name of the Heshbon Expedition. The name Heshbon rather than Hesban indicates the excavators' preoccupation which attempts to illuminate biblical events relating to the site, noted in the Old Testament as Heshbon. The biblical narrative describes that Heshbon was the capital of Sihon, king of the Amorites. When the Israelites arrived from Egypt, they were denied permission to travel through Sihon's estate. A war took place which the Israelites won. The sons of Reuben, then, settled in the city of Heshbon (Numbers 21:21-26,34; Joshua 13:15,17). The original purpose of the Heshbon Expedition was to find support for a hypothetical 15thc. B.C.E. date for these events. However, the earliest strata the excavators discerned was the Iron I period (1200 B.C.E.), indicating that the Israelite conquest of Heshbon turned out not to have occurred. This devastating fact caused the excavators not only to use the name of Hesban instead of Heshbon but also to broaden their concern about the goal of the expedition (LaBianca 1990:21-24).

LaBianca (1990:3) states that the primary purpose of investigation is to reconstruct and analyze various dimensions of long-term changes in human occupation and livelihood. In order to grasp the archaeological record from Tell Hesban as a whole, a new systems perspective was formulated: the food system along with the concepts of intensification and abatement, sedentarization and nomadization (1990:xiii). A food system is a complex unity of all activities carried out by a group of individuals in order to procure, process, distribute, prepare or consume food, and dispose of food remains (LaBianca 1990:9-12).

The food system concept includes all institutions and processes providing and transforming foodstuffs. It focuses on daily activities, examining interactions between populations and their environments while avoiding the sedentary bias. It focuses on hunting and gathering, and on feeding relationships, and provides a framework using varied lines of research (LaBianca 1990:9-12).

The parameters of food system conditions are environment, settlement, land use, operation, and diet. Environment is characterized by plant and animal remains; land use by plant and animal remains, water and soil management works, and settlement conditions; operation by food storage, water management, and food processing installations, market places and road remains; diet by plant and animal remains, human skeletal remains and food residues on pottery (LaBianca 1990:9-12).

LaBianca (1990:xviii) believes that the food system perspective opens the door to understanding long-term cultural changes. The reason is that it has been intimately linked to the concepts of intensification and abatement, sedentarization nomadization. These concepts will help to grasp the long-term changes which have occurred at Hesban. Because the quest for food is likely to involve both genders, all ages, and all classes of society, LaBianca also believes that the food system perspective can shed light on the work worlds and social worlds of men and women, of adults and children, and of rich and poor (1990:xviii).

While the finds at Tell Hesban had not been collected at first with the food system perspective in mind, the Madaba Plains Project at Tell el- 'Umeiri and vicinity had the opportunity from the start to design and conduct a survey based on this perspective (LaBianca 1989:23).

According to Geraty et al (1989:5), changing strategies for obtaining food have determined the changes which turn up archaeologically in settlement and land use patterns, operational facilities, and diet. This assumption is supported by the fact that the largest share of most people's time and energy in antiquity has been devoted to the quest for food. Thus, the excavators regard various activities such as constructing terraces, markets, roads, and storage as interconnected and integrable (Geraty et al:1989:5).

Using the notion of input, the change of food systems is said to intensify or abate depending on increased or decreased input of human management and energy. It seems that intensification and abatement are reflected in the tension between the processes of sedentarization and nomadization and that the processes have occurred side by side in the Madaba Plains. Hence, the task is, Geraty et al (1989:6), states, to ascertain the factors contributing to changes in the rate of sedentarization and nomadization over the time range in which this area was occupied.

This work was hailed by Dever (1993) as the coming of age of Syro-Palestinian archaeology. The publication of this work entailed plentiful strengths, among which include the constant ecological orientation that no previous publication on archaeology in Jordan could match, the regional approach backed by extensive surface surveys coordinated with the overall research design, the unaffectedly systemic nature of the project systematically considering a number of inter-related subsystems, and integrating the research under the title of a suitable and explicit model, that is, "food systems" (1993:130).

4. Critique of General Systems Theory

In his book, Introduction to Prehistory: A Systemic Approach, Rouse (1972:245) describes the need for General Systems Theory as follows:

"We must develop an objective, pure scientific approach because there are so many different ethnic groups in today's world and because all are potential sources of conflict. We shall never be able to achieve lasting peace---until we are able, by the use of concepts [systemic approach] like those presented in the present volume, to recognize the existence of other groups and subgroups, to understand and respect their ways of life, and to mutually adjust to them. Upon our ability to do so rests the future of the world." In retrospect, this positivism that General Systems Theory would produce a general law has never been realized (Wenke 1981:102) and to our disappointment, it is unlikely to happen in the future.

Redman (1973:16) defines a system as "a functioning set of elements that are interrelated so that a change in one affects the others." However, the definition of system has never been solved. There are almost as many different views of systems and systems theory as there are theoreticians and practitioners (Salmon 1978:177; Hill 1977:61,101; and Wenke 1981:101). Hill (1977:100) also thinks that it may be fruitless to try to establish such concepts as "chiefdom" and "state" as empirical entities because they may never be quantitatively measurable, and will remain unoperational.

As Hodder (1986:32) indicated, the systems approach is not able to account for the great richness, variability and specificity of cultural production, and individuals and their shared thoughts are passive by-products of the system; human activity is timeless, the product of systemic inter-relationships rather than being historically derived. One may question whether we have to analyze forever that one behavior is an example of positive feedback and the other is something else (Wenke 1981:102).

Although Plog (1975:215) applauded the work of Flannery (1968), there are some serious critiques about his work. Wenke (1981:101) points out that few new data were presented and that Flannery simply re-casted the data in systems theory terminology. In terms of regulatory mechanisms, seasonality and scheduling, Flannery's work does not require elaboration of the negative feedback (Salmon 1978:178). Furthermore, as Hodder (1986:27) sharply mentioned, by disregarding production, creation and innovation, and by only looking at the adaptive qualities of a system, we cannot explain how that system developed; neither can we explain how people come to accept the new system.

Why, as Trigger (1978:11) states, have archaeologists tended to use General Systems concepts in a piecemeal fashion, rather than seeking to construct an integrated body of theory? Salmon (1978:174) answers that archaeological theory cannot be extracted from General Systems Theory. Construction of a theory of great generality is not even in sight. There is no answer in General Systems Theory to questions such as "What are the components of archaeologically interesting systems?" and "What are the important relations among these components?" (1978:177).

5. Contributions of General Systems Theory to Archaeology

Systems theory has contributed to archaeological research in its modeling techniques. Two of these are especially important: the diagram or flowchart and the simulation models. Although archaeologists do not claim that either technique has an exclusive association with general systems theory, they developed their interests in the techniques through the literature. Diagrams and simulation models are now imperative parts of archaeological research (Plog 1975:216; Watson, Leblac and Redman 1971:85; Hill 1977:102; and Redman 1973:20).

Another contribution of Systems Theory is that it emphasized the great complexity of cultural processes and organization; that is, systems are complex. This complexity demanded that archaeological fieldworks be conducted with it clearly in mind. Sampling must be possible by data collection and analysis that emphasized the variability of records (Redman 1973:18). The use of statistics and computers is necessary for dealing with the massive data (Dever 1981:17). Ecological aspects are also considered an integral part of knowing the past environment (Willey and Sabloff

1980:186).

The attempt to develop research designs of the New Archaeology has had a significant impact on our branch of archaeology, Syro-Palestinian archaeology. The developing of research designs is carried out using the notion that culture is a system composed of subsystems. This concept is based on the General Systems Theory first advanced by von-Bertalanffy (1968), successfully applied to archaeology by Flannery (1968), and enhanced by Clarke (1978). The necessity to make explicit what we are trying to learn has brought our branch of archaeology from the descriptive into the explanatory stage: Syro-Palestinian archaeology has moved toward a true discipline, thanks to the New Archaeology strongly influenced by General Systems Theory. Regardless of the faults indicated by the critics, General Systems Theory certainly made significant contributions to the history of archaeological research.

6. Conclusion

In conclusion, with regard to General Systems Theory, we have reviewed the exemplary study of Clark, the applications of the theory, its critique and the contributions to our branch of archaeology, Syro-Palestinian archaeology. Clark (1978) made the most detailed discussion of the utilization of systems thinking in archaeological research. Common properties found in several system classes include feedback, equilibrium, homeostasis, regulation and control, limits and networks, adaptation and directive correlation, problem of black box and game theory.

The exemplary applications of General Systems Theory are Flannery's study of Mesoamerica and the Madaba plains project in Jordan. Considering man and the southern highlands of Mexico as a single complex system, Flannery (1968) investigated the system consisting of many mutually influencing sub-systems between 8000 B.C.E. and 200 B.C.E. The Madaba plains project had various strengths such as the constant ecological orientation, the regional approach backed by extensive surface surveys under the overall research design, the unaffectedly systemic nature of the project systematically studying numerous inter-related subsystems, and integrating the research under the explicit model, "food systems".

Despite many efforts of the past decades, General Systems Theory has not realized a general law and may not in the future. The systems approach is unable to explain the great richness, variability and specificity of cultural production, and individuals and their shared thoughts are passive by-products of the system; human activity is timeless, the product of systemic inter-relationships rather than being historically derived. Archaeological theory cannot be extracted from General Systems Theory.

Systems theory has contributed to archaeological research in its modeling techniques. It also emphasized the great complexity of cultural processes and organization; that is, systems are complex. The developing of research designs is carried out using the notion that culture is a system composed of subsystems. This concept is based on the General Systems Theory first advanced by von-Bertalanffy (1968), successfully applied to archaeology by Flannery (1968), and enhanced by Clarke (1978). The necessity to make explicit what we are trying to learn has brought our branch of archaeology from the descriptive into the explanatory stage: Syro-Palestinian archaeology has moved toward a true discipline, thanks to the New Archaeology strongly influenced by General Systems Theory. Regardless of the faults indicated by the critics, General Systems Theory certainly made significant contributions to the history of archaeological research.

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