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Social Archeology

Beyond Subsistence and Dating

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ACADEMIC PRESS New York San Francisco London
A Subsidiary of Harcourt Brace Jovanovich, Publishers

ACADEMIC PRESS, INC.
111 Fifth Avenue, New York, New York 10003

United Kingdom Edition published by
ACADEMIC PRESS, INC. (LONDON) LTD.
24/28 Oval Road, London NW1 7DX

Library of Congress Cataloging in Publication Data

Main entry under title:

Social archeology:
Beyond subsistence and dating.

(Studies in archeology)
Includes bibliographies.
1. Archaeology--Methodology--Addresses, essays, lectures. 2. Man, Prehistoric--Addresses, essays, lectures. I. Redman, Charles L. II. Berman, Mary Jane. III. Curtin, Edward V. IV. Langhorne, Jr. William T. V. Versaggi, Nina M. VI. Wanser, Jeffery C.
CC75.7.S6 930'.1'028 78-16390
ISBN 0-12-585150-2

PRINTED IN THE UNITED STATES OF AMERICA

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chapter 5

Information Sources and the Development of Decision-Making Organizations

GREGORY A. JOHNSON

A number of recent studies have emphasized the potential explanatory importance of information transfer and processing, or decision making, in the investigation of the development of urbanism (Törnqvist 1968; Wright 1969), states (Johnson 1973; Wright and Johnson 1975), and societies in general (Naroll 1956; Flannery 1972). This chapter constitutes a more detailed consideration of a model suggested by Wright and Johnson (1975:285), which incorporates a principle of "requisite variety" and an assumption of cost–benefit optimization to examine variable relationships involved in increasing complexity of societal-level, decision-making or administrative organizations.

Decision-making hierarchies essentially allow the coordination of a larger number of activities and/or integration of a larger number of organizational units than would be possible in the absence of such hierarchies. Decision-making organizations increase in complexity through two basic processes: horizontal and vertical specialization (Simon 1944). Horizontal specialization increases the number of decision-making units at a given level of a decision hierarchy, whereas vertical specialization

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increases the number of hierarchic arranged levels of such an organization.

The general relationship between a decision-making organization (regulatory mechanism) and the activities or units integrated by this mechanism may be considered to be a special case of the relationship described by a principle of requisite variety (Ashby 1968:135). This principle is one of the foundations of regulation theory, and states that given two interdependent sets, variety in one set can only be reduced by increment in variety in the other set. To phrase it in terms of the present case, variety in decisions required to integrate a set of units or activities in the absence of a specialized integrative mechanism can only be reduced by the development of such a mechanism. Further, independent increase in the variety of decisions required to integrate a system already regulated by a specialized decision-making organization can only be reduced by increment in the variety of decisions made by that organization. As will be shown in the following discussion, increment in decisions made selects for increment in the complexity of a decision-making organization.

An initial assumption of cost–benefit optimization is the second major factor in the present model. Given pressure for increase in the complexity of a decision-making or administrative organization, such increase might be accomplished in a variety of ways. Not all of these possible alternatives, however, will be equally efficient. A cost–benefit optimization assumption will be used to generate a baseline of most efficient increase in organizational complexity, aganist which the implications of specific deviations from efficiency maximazation may be evaluated.

A formal model for the development of decision-making organizations is presented in the following pages. Although this model is a simple one, its construction requires a rather tedious process of definition of variables, examination of assumptions, and numerical illustration of variable relationships. The reader may find it useful to refer to the summary flowchart for the model (Figure 5.5, p. 98) while considering this section. A variety of possible anthropological implications of the model are discussed in the latter portion of this chapter.

DEFINITIONS AND ASSUMPTIONS OF THE MODEL

The following definitions are required:

1. *Information*: "Information is defined, in general, as that which causes or logically validates representational activity—activity in which a structure, purporting to represent something else, is produced or augmented [Mackay 1969:133]."
2. *Source*: The minimal organizational unit under consideration. Types of source units may include territorial units, population units, residence units, activity units, etc.
3. *Source channel*: An information transfer channel between two sources, or between a source and a vertical control unit.
4. *Source channel-monitoring work unit*: The work involved in monitoring one source channel.
5. *Source integration*: Activity integration between or among sources.
6. *Source integration work unit*: Work involved in integration of two sources.
7. *Vertical control unit*: An organizational unit specialized in providing integration among sources or lower-level vertical control units.
8. *Source–control integration*: Activity integration between sources and control unit(s).
9. *Source–control integration work unit*: Work involved in activity integration between one source and one control unit.
10. *Control channel*: An information transfer channel between two control units.
11. *Control channel-monitoring work unit*: Work involved in monitoring one control channel.
12. *Control unit integration*: Activity integration between or among control units.
13. *Control integration work unit*: Work involved in activity integration between two control units.
14. *Channel capacity*: Maximum amount of information that may be transferred in a single channel with minimal information loss.
15. *Administrative advantage*: The proportional relationship of work load savings due to increment in the complexity of a control mechanism to the total work load required to obtain those savings.
16. *Administrative efficiency*: Administrative advantage per unit work load required with increase in the number of sources being integrated by a control mechanism.
17. *Control mechanism*: An organization specialized in providing integration among sources.

The following assumptions are required:

Entire Model:

1. The number of information sources integrated increases at a uniform rate.
2. Complete source integration is maintained.
3. Individual information channel loads are maintained within channel capacity.
4. Organizational decisions are made so as to maximize administrative advantage or efficiency.

Stage I (horizontal integration):

5. Information sources produce equivalent information output.
6. Information sources involved equivalent channel-monitoring work.
7. A source integration work unit is equivalent to a source channel-monitoring work unit.

Stage II (vertical integration—one vertical control unit):

8. A source–control integration work unit is equivalent to a source integration work unit.

Stage III (vertical integration—multiple vertical control units):

9. Control units produce equivalent information output.
10. Control unit information channels involve equivalent channel-monitoring work.
11. A control channel-monitoring work unit is equivalent to a source integration work unit.

Stage IV (second-order vertical integration—one control unit):

No additional assumptions required.

Beyond efficiency maximization, three of the assumptions just cited require special comment. These are: (*a*) maintenance of channel loads within channel capacity, (*b*) equivalency of channel-monitoring and source and/or control unit integrative work, and (*c*) maintenance of complete integration. Given assumption (*a*) arbitrary values may be assigned to the types of work involved in assumption (*b*). In that I have no present way to evaluate relative work load involved in these two activities, I will assume that they are equivalent and set the value of a work unit of each type at 1.0. Finally, the assumption of maintenance of complete integration allows this variable to be treated as a constant.

A more sophisticated approach to the type of model presented here would involve systematic consideration of the implications of deviation from the model's basic assumptions. Only implications of deviation from efficiency maximization will be considered in the following discussion.

One additional point must be made here. Increasing organizational complexity is generated in the following model through continued increment in the number of information sources integrated. The model attempts to describe various organizational responses to system growth, not explain that growth.

THE MODEL

Given the definitions and assumptions just described, we may proceed to the model itself. The first issue to be considered involves the relationship between increase in number of information sources integrated and work load required to achieve that integration in the absence of a vertically specialized control mechanism. In this situation the number of one-to-one relationships among the activity or other units that constitute effective information sources will be equivalent to the number of one-to-one information channels linking those units. Figure 5.1 (see also Table 5.1) graphically presents the relationship between increase in number of sources and increase in work load required to integrate those sources. This relationship is clearly nonlinear. Increase in sources produces increase in work load per source required for integration. As discussed previously, this work load may be decreased by the development of a specialized vertical control mechanism. The question becomes one of at what point development of such a mechanism would become efficient.

Figure 5.2 plots administrative advantage of a single-unit vertical control mechanism against work load required for integration of increasing numbers of sources. It is evident that development of such a mechanism (first-order vertical specialization) first results in overall work load reduction when six information sources are integrated. Note that these savings are obtained by reduction of the number of information channels that must be monitored to achieve integration. Vertical specialization thus reduces work load involved in information transfer.

Although work load savings obtained by initial vertical specialization increase with increase in sources integrated, the rate of such increase declines rapidly. This decline constitutes increasing pressure for division of labor (horizontal specialization) within this single-unit vertical control mechanism. Again the question is one of at what point such specialization

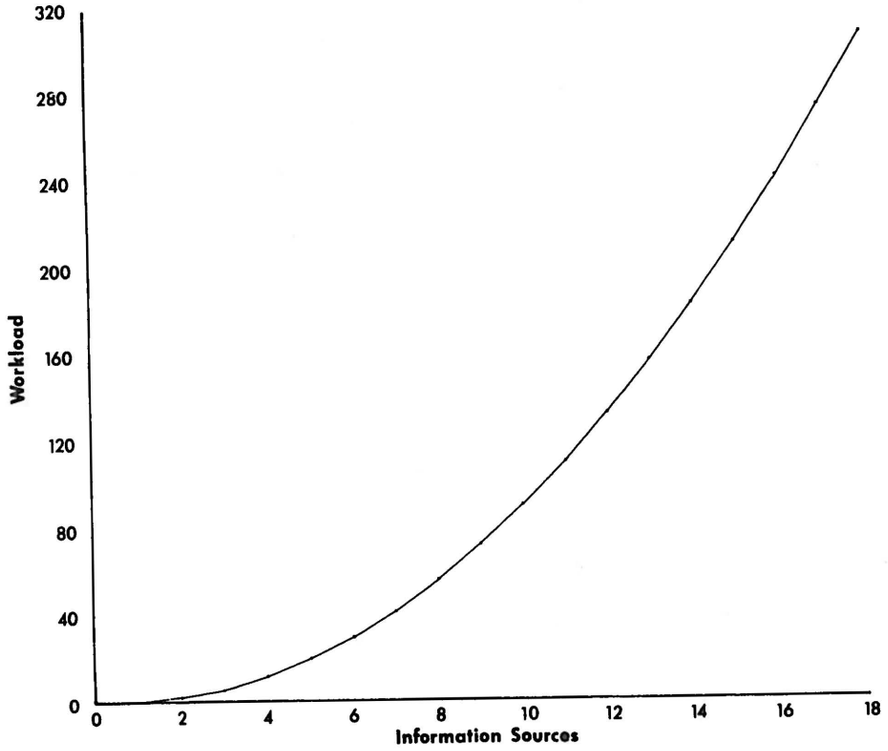

Figure 5.1. Cost of horizontal integration.

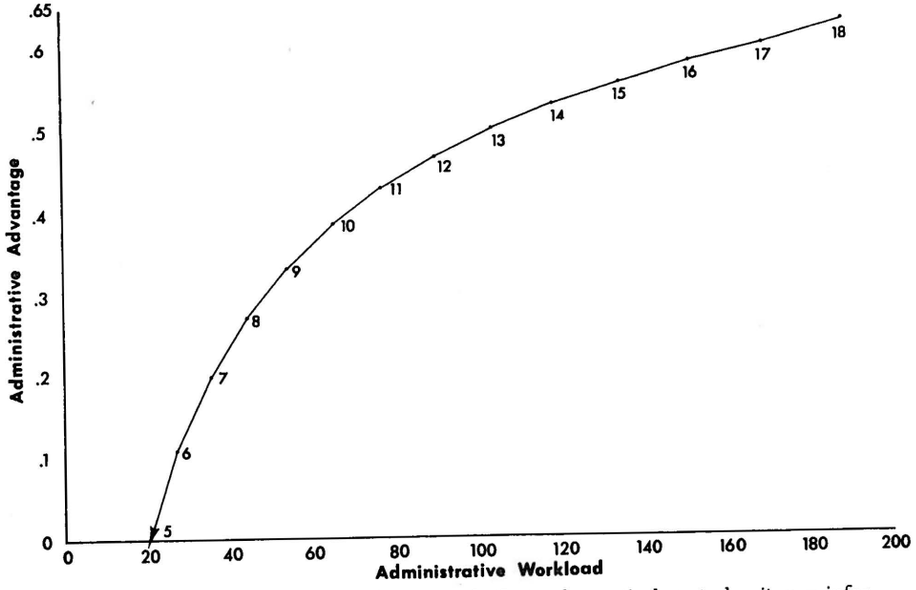

Figure 5.2. Administrative advantage of a first-order vertical control unit. n = information sources.

Table 5.1
WORKLOADS INVOLVED IN SYSTEM INTEGRATION: HORIZONTAL AND FIRST-ORDER VERTICAL CONTROL UNITS

Horizontal control			
Sources	Source channels	Source integration	Total work
1	0	0	0
2	1	1	2
3	3	3	6
4	6	6	12
5	10	10	20
6	15	15	30
7	21	21	42
8	28	28	56
9	36	36	72
10	45	45	90
11	55	55	110
12	66	66	132
13	78	78	156
14	91	91	182
15	105	105	210
16	120	120	240
17	136	136	272
18	153	153	306
19	171	171	342
20	190	190	380

Vertical control						
Source channels	Source integration	Source control integration	Total work	Work savings	Administrative advantage	Administrative efficiency ($\times 10^{-2}$)
1	0	1	2	−2	—	—
2	1	2	5	−3	—	—
3	3	3	9	−3	—	—
4	6	4	14	−2	—	—
5	10	5	20	0	0	0
6	15	6	27	3	.111	.412
7	21	7	35	7	.200	.571
8	28	8	44	12	.272	.618
9	36	9	54	18	.333	.616
10	45	10	65	25	.384	.590
11	55	11	77	33	.428	.555
12	66	12	90	42	.466	.517
13	78	13	104	52	.500	.480
14	91	14	119	63	.529	.444
15	105	15	135	75	.555	.411
16	120	16	152	88	.578	.380
17	136	17	170	102	.600	.352
18	153	18	189	119	.629	.332
19	171	19	209	133	.636	.304
20	190	20	230	150	.652	.283

would be expected to occur. This problem may be approached in two ways. Figure 5.3 presents a plot of administrative efficiency of a single-unit vertical control mechanism on number of information sources regulated. Note that efficiency peaks at integration of eight sources, and declines thereafter. Such diminishing returns in efficiency would provide one pressure for horizontal specialization.

A second approach to this problem is illustrated in Figure 5.4 (see also Table 5.2), which presents a plot of administrative advantage of horizontal specialization on work load associated with such specialization. Note that in terms of overall work loads, a two-unit, first-order, vertical control mechanism is more efficient than a single-unit mechanism when six sources are integrated. Thus initial development of a first-order control unit is associated with immediate selective pressure for horizontal specialization of that unit.

Figure 5.4 also plots efficient points for subsequent horizontal specialization of a first-order, vertical control mechanism to a maximum of six units. Work load savings are obtained by reduction of the number of source relationships that must be considered and decisions that must be made to achieve source integration. Horizontal specialization thus reduces work load involved in information processing.

Figure 5.4 also illustrates that absolute gains in administrative advantage obtained by horizontal specialization decrease as such specialization continues. These diminishing returns of horizontal specialization constitute effective selective pressure for second-order vertical specialization. As in the case of first-order vertical specialization, second-order specialization becomes efficient when six sources must be integrated. In this case, the six information sources involved are the six horizontally specialized units of a first-order, vertical control mechanism.

Figure 5.5 presents a flowchart of variables, variable relationships, and transformation formulae necessary to generate a second-order, vertical control unit. Note the three primary negative feedback loops incorporated in this information. Initial vertical specialization reduces the number of source channels that must be monitored in order to achieve system integration. Horizontal specialization of a first-order control unit reduces work load involved in explicit source integration. Second-order vertical specialization reduces the number of control channels that must be monitored to achieve system integration.

Two positive feedback loops are of interest. Both vertical specialization and horizontal specialization of a vertical control unit *permit*, in general, some degree of subsequent increment in number of sources integrated without further elaboration of the control mechanism. This is

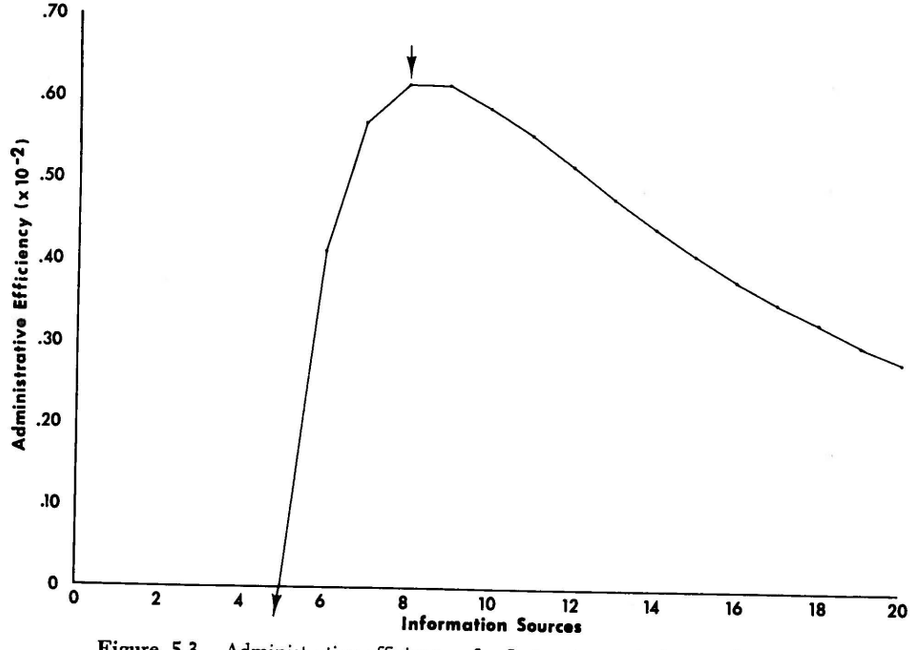

Figure 5.3. Administrative efficiency of a first-order vertical control unit.

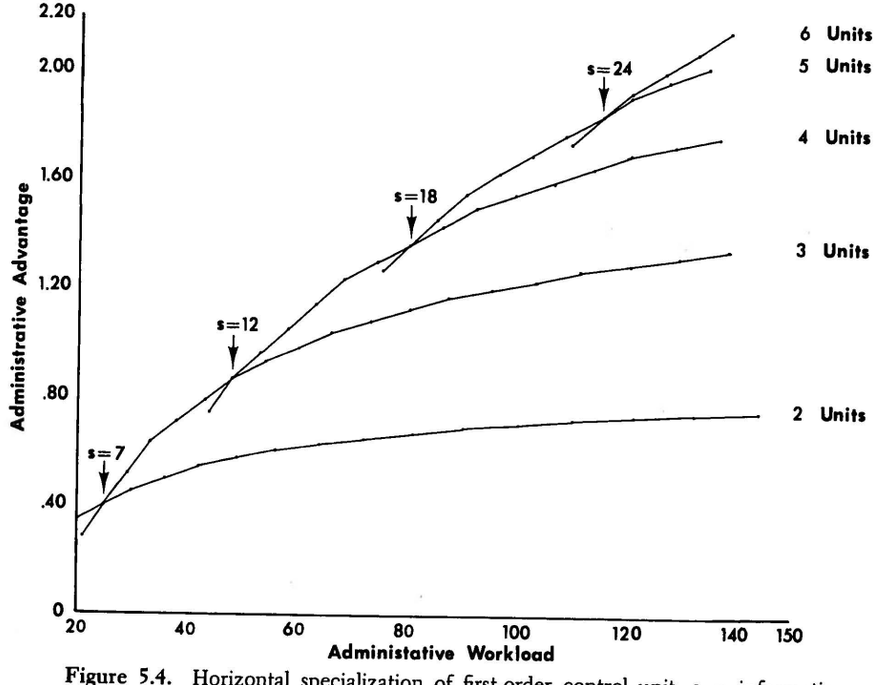

Figure 5.4. Horizontal specialization of first-order control unit. s = information sources.

Table 5.2

WORK LOADS INVOLVED IN HORIZONTAL SPECIALIZATION OF A FIRST-ORDER VERTICAL CONTROL UNIT

Vertical control	
Sources	Total work
6	27
7	35
8	44
9	54
10	65
11	77
12	90
13	104
14	119
15	135
16	152
17	170
18	189
19	209
20	230

Horizontal specialization of vertical control (two units)							
Source channels	Source integration	Source–control integration	Control channels	Control integration	Total work	Savings	Administrative advantage
6	6	6	1	1	20	7	.350
7	9	7	1	1	25	10	.400
8	12	8	1	1	30	14	.460
9	16	9	1	1	36	18	.500
10	20	10	1	1	42	23	.547
11	25	11	1	1	49	28	.571
12	30	12	1	1	56	34	.607
13	36	13	1	1	64	40	.625
14	42	14	1	1	72	47	.652
15	49	15	1	1	81	54	.666
16	56	16	1	1	90	62	.688
17	64	17	1	1	100	70	.700
18	72	18	1	1	110	79	.718
19	81	19	1	1	121	88	.727
20	90	20	1	1	132	98	.742

an enabling relationship. Neither type of specialization generates increase in basic information sources. As stated previously, such increase is related to variables not included in the present model.

The efficient development of a decision-making organization is ex-

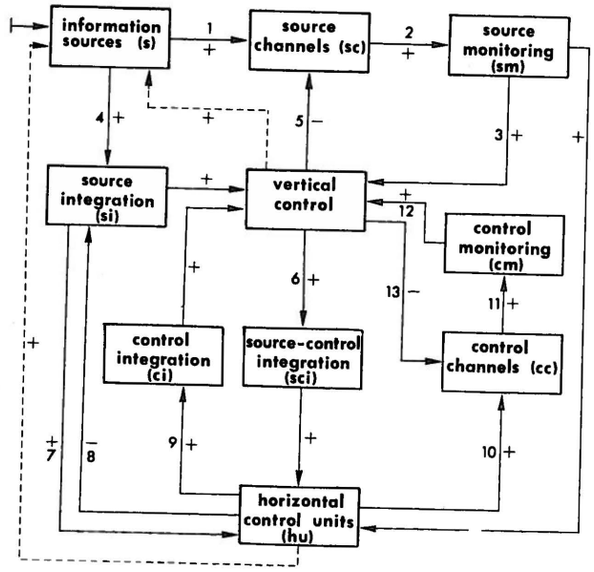

Figure 5.5. Development of second-order vertical control unit—flowchart. Notes: 1: $sc = (s^2 - s)/2$ (Dubin 1959); 2: $sm = sc$; 3: when $s \geq 6$; $si = (s^2 - s)/2$; 5: $sc = s$; 6: $sci = s$; 7: when $s \geq 6$; 8: $si = [(s^2/hu) - s]/2$; 9: $ci = (hu^2 - hu)/2$; 10: $cc = (hu^2 - hu)/2$; 11: $cm = cc$; 12: when $s \geq 24$; 13: $cc = hu$.

tended to the point of third-order vertical specialization in Figure 5.6. Here administrative work load is plotted against complexity of decision-making organization. Prior to initial vertical specialization, this complexity is measured simply as the number of horizontal units integrated in the system. With initial vertical specialization, complexity is measured by the number of units involved in a most efficiently organized control mechanism.

Figure 5.6 illustrates that efficient increase in complexity of a control mechanism is associated with effective step functions in administrative efficiency. Vertical and immediately subsequent horizontal specialization of such a control mechanism results in absolute decrease in work load involved in the integration of an increasing number of sources. I would suggest that the presence of such step functions has important implications for the investigation of the evolution of social systems. Not only do these step functions indicate points of critical evolutionary change, but they also allow partitioning of a continuum of such change into theoretically justifiable analytical units.

The model as developed thus far, has relied on an assumption of cost–benefit optimization. One of the most interesting aspects, however,

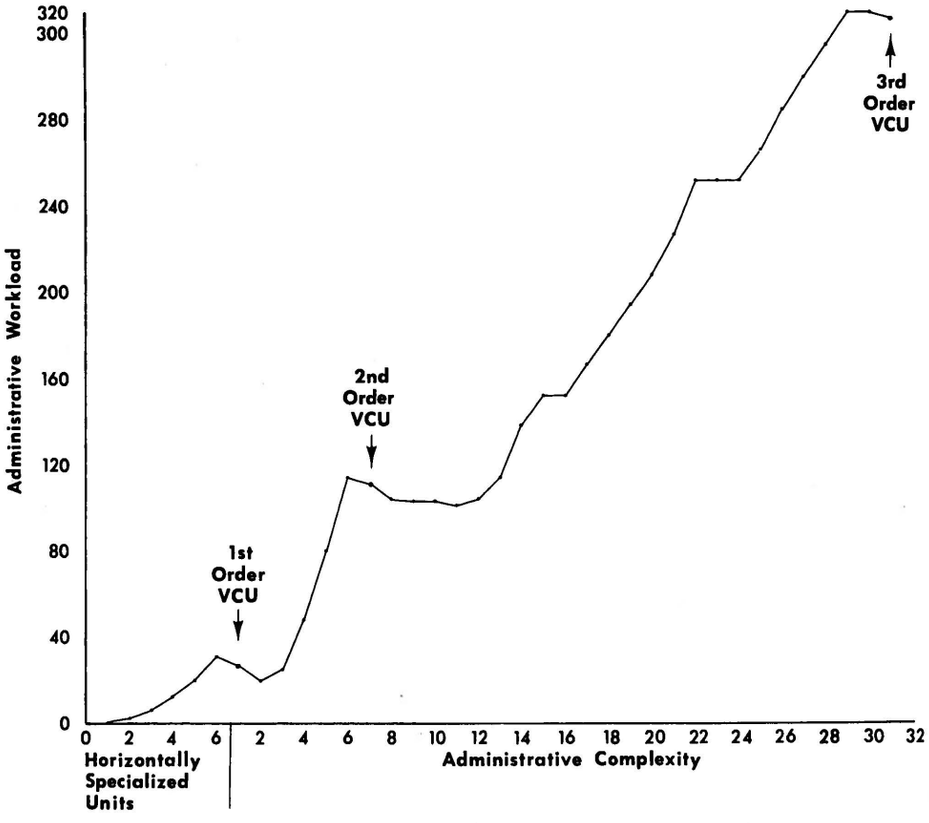

Figure 5.6. Development of efficient administrative organization. *VCU* = vertical control unit.

of any maximization model is the implications of deviation from maximizing assumptions. Figure 5.7 presents plots of administrative work load on number of information sources integrated, given a baseline efficiency maximization and two types of deviation from this assumption. Plot A illustrates the effects of suppression of first-order vertical specialization, whereas plots B and C illustrate the effects of suppression of horizontal specialization of first- and second-order vertical control units. In all three cases, deviation from a maximizing assumption involves marked increases in work load required for source integration.

If work loads may be directly related to effective costs, the increasing costs of deviation from efficiency in system integration may be related to an increasing probability of system failure. Identification of social processes that facilitate and those that inhibit cost–benefit optimization in

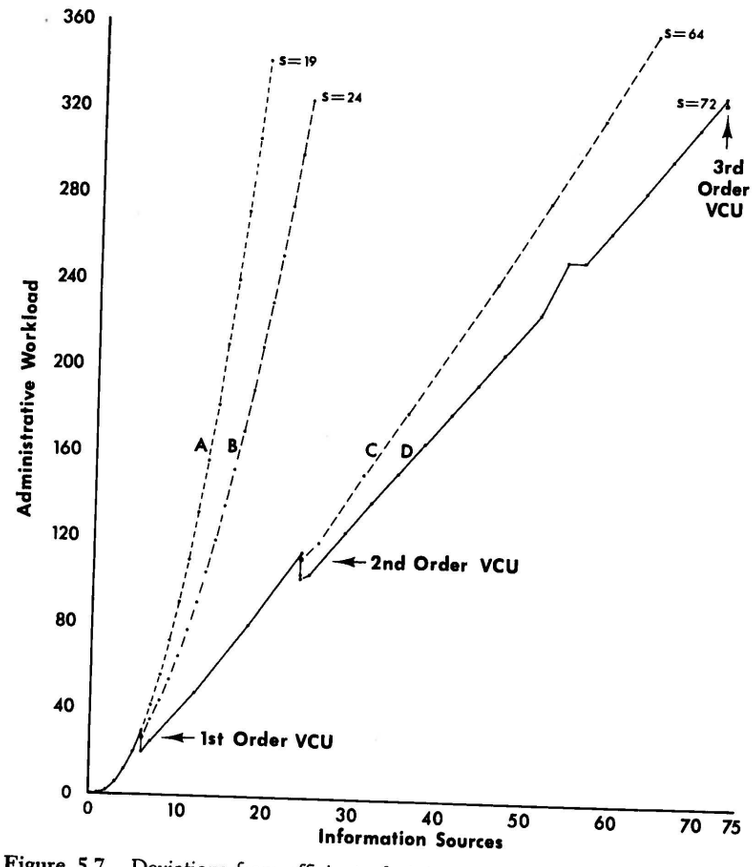

Figure 5.7. Deviations from efficient administrative development. *s* = information sources; *VCU* = vertical control unit. *A*: First-order vertical specialization suppressed. *B*: Horizontal specialization of first-order *VCU* suppressed. *C*: Horizontal specialization of second-order *VCU* suppressed. *D*: Efficient development of administrative organization.

the organization of societal-level control mechanisms should provide one source of explanation for the continued development, or breakdown and failure, of social systems.

Before continuing with a more detailed consideration of various implications of the present model, it might be well to summarize the basic observations made thus far.

1. Increase in the number of information sources integrated in a system selects for increase in the complexity of the system's control mechanism.

2. Vertical specialization in administrative organizations reduces work load involved in channel monitoring (information transfer).
3. Horizontal specialization in administrative organizations reduces work load involved in explicit source integration. Since such integration directly involves decision making, the work load reduction involved is in information processing.
4. Efficient increase in administrative complexity produces step functions in administrative efficiency.
5. Suppression of vertical and/or horizontal specialization in administrative organizations produces marked increase in work loads and costs involved in system integration.

IMPLICATIONS OF THE MODEL

A model of the sort presented here would be of little anthropological interest if it could not be more directly related to specific behavioral problems. In the following sections, an attempt is made to discuss specific social, organizational, and spatial implications of this model.

Suppression of first-order vertical specialization has been shown to involve major increments in information transfer and processing costs. At the societal level such specialization is presumably inhibited or facilitated by explicitly social factors. It is possible that selective pressure for initial vertical specialization of a societal-level, decision-making organization also selects for the development of ascribed status differentials and regularized status inheritance rules (ranking systems) as one possible social strategy for the solution of problems inherent in the operation of a vertically specialized organization.

These problems may be divided into two categories: those involved in decision making and those involved in decision implementation. Decision-making problems would seem to include recruitment and training of personnel, and general maintenance or organizational continuity. Decision implementation requires that the general population of a society acquiesce to and carry out operational aspects of decisions made by vertically specialized personnel.

Decision implementation has received considerable anthropological attention in discussion of such topics as influence, authority, law, and power. Here influence will be defined as the ability of one individual or organization unit to initiate, modify, or terminate specific behavior or types of behavior of another individual or unit. Use of social status differences to structure or supplement differential influence in decision-

making organizations has been frequently noted (Sutherland 1975:290; Udy 1970:48; Wallace 1971:5). Simply stated, if differences in social status are positively related to differences in influence, then incorporation of individuals of differentially higher status in a decision-making hierarchy should increase the probability of decision implementation.

In evolutionary terms, I would expect a high degree of association among initial vertical specialization of decision-making systems, development of ascribed social status differences, and increment in effective influence. Thus in Fried's (1967:110 ff.) discussion of the evolution of political society, ranked societies are differentiated from egalitarian ones partially by the development of: (*a*) specialized leadership; (*b*) ascribed social status differences; and (*c*) increase in authority.

Decision implementation, however, is of little importance if decisions are not made. As mentioned previously, decision making in a vertically specialized system may involve problems of personnel recruitment and training, and of organizational continuity. Specialized decision making involves nongeneral knowledge and skills acquired during a training period. Decision-making positions may be highly valued because of their social and/or material rewards. A regularized recruitment system may serve to reduce potentially disruptive competition and dissension in selection of individuals to occupy such positions, although succession conflicts may still be common in hereditary systems (Burling 1974:13 ff.). Finally, lack of organizational continuity may involve changes in operating procedure that inhibit organizational efficiency.

If status differences function to increase the probability of decision implementation, then the development of regular status inheritance rules may reduce problems of recruitment, training, and continuity. Such inheritance systems would function to designate probable individuals to eventually occupy decision-making positions. A high-status child living in close proximity to a high-status decision maker would be afforded the opportunity of training by example for future decision-making activity. A system in which decision-making positions are effectively inherited would also provide an increased probability of organizational continuity.

Sahlins's (1963) distinction between "big-man" societies and "petty" chiefdoms in Melanesia and Polynesia would seem to reflect these predicted social responses to problems related to initial vertical specialization of a decision-making system. Although functioning with specialized leaders, big-man systems lack regularized provision for recruitment, training, and continuity, as well as the real or potential increase in effective influence characteristic of petty chiefdoms.

The hypotheses I have just suggested are summarized in Figure 5.8 and suggest that development of ranking systems may be associated with

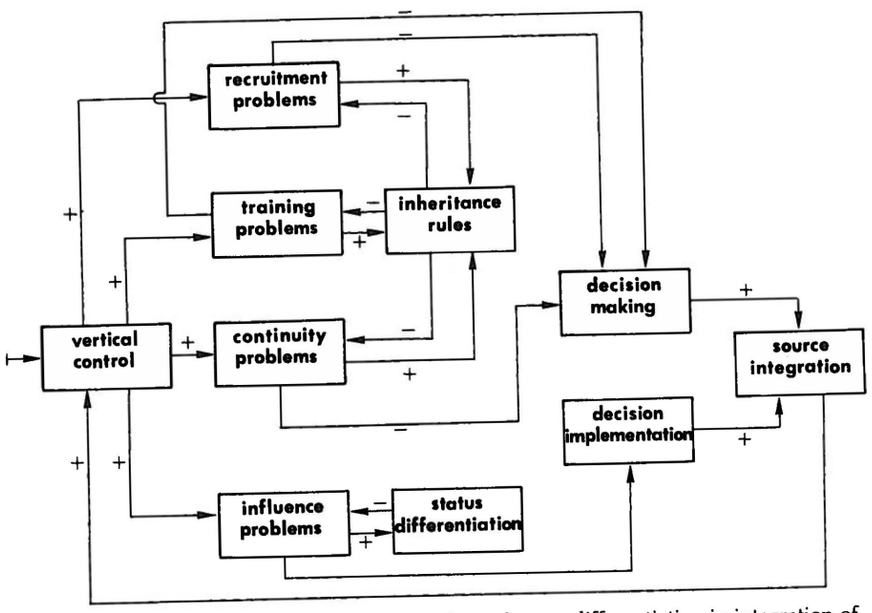

Figure 5.8. Function of inheritance rules and status differentiation in integration of information sources—flowchart.

increment in the number of information sources integrated on a societal level. Fried (1967:183) suggests five processes as being among those potentially leading to the development of ranking systems.

1. "Maintaining connections between parent settlements and those that have budded off; . . ."
2. "Diversifying the consuming sector of the economy by maintaining regular trade relations with communities exploiting somewhat different resources; . . ."
3. "Better handling of food supply by organizing special labor forces for simple irrigation tasks; . . ."
4. "Rationalization of a sequence of habitation in which original settlers are joined, albeit peaceably, by subsequent settlers; . . ."
5. "Formalization, as Service has pointed out, of trans-settlement sodalities, often as a means of enlarging the area of relative peace."

Note that processes 1, 4, and 5 involve increment in residence and/or population units as information sources, whereas processes 2 and 3 involve increment in residence and/or activity units as information sources.

Simple population increase within a context of limited resources has also been cited by Carneiro (1970:736) and Burling (1974:18) as generating status differences in order to reinforce leadership in intergroup conflict. It would seem that each of these suggested processes may be considered to be a special case of a more general organization model.

One would expect that the more complex the decision-making organization, the more serious the problems just discussed might be. To the extent that these problems can be resolved in the context of social organization, increment in information sources integrated and associated increment in the complexity of a decision-making organization should select for increasing social status differentiation and increasing regularity of status inheritance. Thus, primogeniture, which provides very specific designation of status inheritance and long training periods as well as considerable continuity, is apparently characteristic of complex kin-based societies (Service 1975:74). It seems that many of these societies are also characterized by marked social stratification (Sahlins 1958).

Sahlins's work on social stratification in Polynesia is of particular interest here in that "it was suggested, therefore, that stratification is directly related to productivity, [and] productivity was measured by the number of people embraced in the largest redistributive network of food and how frequently this overall network was utilized [Sahlins 1958:249]." The Polynesian cases examined by Sahlins would seem to reflect an expected high correlation between degree of social stratification and number of population units as information sources integrated.

I do not mean to imply that this organization model can account for the origin and development of status differentiation and status inheritance rules in general. I would suggest, however, that such developments constitute one viable social alternative to the resolution of critical problems generated by initial vertical specialization in societal-level, decision-making organizations. Whatever the specific mechanisms involved, it is clear that the increasing costs of failure to resolve such problems have grave implications for the future of a society.

Suppression of first-order vertical specialization is, however, only the first of the two major evolutionary problems I have defined. The second was suppression of horizontal specialization of a highest-order control unit. Recall from Figure 5.7 that in terms of increasing costs, suppression of horizontal specialization of this sort is much more cost intensive in a system with a first-order than in one with a second-order, vertical control mechanism. This might suggests that in evolutionary terms this problem of horizontal specialization decreases in significance with increasing complexity of a system. Further considerations, however, suggest that this view would be incorrect.

Here it might be suggested that despite selective pressure for administrative efficiency, one major factor leading to suppression of horizontal specialization is probably the resistance of individuals holding positions in such a vertical control unit to the effective division of administrative influence or power that such specialization would entail. Differently phrased, nonadministrative considerations may produce attempts to maintain effective concentration of political power.

This problem has recently been considered in some detail by Burling (1974). He concludes that power sharing of this sort is relatively rare and often beset when present by disagreement among coequal leaders and breakdown in the coordination of their activities (Burling 1974:255). In that there seems to be a high positive correlation between vertical complexity of an administrative organization and the amount of political power involved in such a system (Wirsing 1973:153), resistance to horizontal specialization (power sharing) may be positively correlated with overall administrative complexity. In contradiction to this expectation, Burling (1974:153) suggests that such power sharing is more common in complex than in simpler societies.

The problem is not one that will be resolved here. I suspect, however, that much of the ethnographic record fails to distinguish between ostensible administrative role and actual administrative function. A king may reign, but a council of ministers may rule. The proportionally high incidence of power sharing in complex, not to say modern, societies cited by Burling may simply reflect a decline in the ability to disguise effective coequal leadership with a variety of social fictions.

ORGANIZATIONAL AND SPATIAL IMPLICATIONS OF THE MODEL

In the following pages, specific numerical implications of the present model are examined with ethnographic, geographic, and archeological data. Such examination is undertaken with considerable trepidation. There is no a priori reason to believe that such a simple model, based on such restrictive assumptions, should provide an accurate description of real-world processes. As will be seen in the following discussion, however, there is a rather remarkable fit between various model predictions and various classes of field data. This fit is best intepreted as indicative of the potential utility of an organization theory approach, rather than of the predictive power of the present formulation.

One of the more interesting parallels between present model predictions and field data is in the area of the organization of administrative hierarchies. In the context of a much more general cross-cultural study of the organization of work in nonindustrial societies, Stanley Udy (1959, 1970) attempts to predict the number of levels of management hierarchy appropriate to coordination of a given number of activities. Such prediction involves estimation of the maximum number of activities that any given administrator can effectively coordinate. Udy (1959:38) cites a number of studies in experimental psychology indicating that the maximum number of items to which an individual can give simultaneous attention ranges between three and seven, with a mode of five. Udy's (1970:50) own data suggest that in activity coordination, this number is probably four.

Tables 5.3a and 5.3b present administrative organizations of various degrees of complexity as predicted by the present information model. The figures in Table 5.3a were generated with an efficiency maximization assumption, whereas those in Table 5.3b reflect the results of suppression of horizontal specialization of a second-order, vertical control unit.

The numbers of administered units at various levels of a given administrative hierarchy are not even multiples of a base number but exhibit considerable variability from one organization to the next. Across the whole organizational range considered, however, the mean number of organizational units integrated by an immediate superior unit in an administrative hierarchy generated on an assumption of efficiency maximization is 3.66, with a range of 2.33 to 6.00. This mean of 3.66 is a reasonable approximation of Udy's figure of 4.0, and the range of 2.33 to 6.00 is remarkable close to that of 3.0 to 7.0 reported in the psychological literature.

The figures in Table 5.3b are of additional interest. Given suppression of horizontal specialization of a second-order, vertical control unit, the average number of organizational units integrated by an immediately superior unit is increased to 7.25, with a range of 3.0 to 15.0. It would seem that this particular form of deviation from efficiency considerations not only results in marked increase in work loads as shown previously but also produces a work load that may severely tax individual or unit capacities.

Evolutionary problems of power sharing were discussed in an earlier section of this chapter. Given present considerations, we might predict that systems in which a single highest-order control unit attempts to integrate a number of immediately subordinate units markedly in excess of six or seven is under considerable selective pressure for horizontal specialization of that highest-order unit. In societal-level systems, such

Table 5.3a

UNITS OF ADMINISTRATIVE ORGANIZATION—EFFICIENT DEVELOPMENT[a]

Levels of hierarchy														
3														1
2								1	2	3	4	5	6	6
1		1	2	3	4	5	6	6	3–3.5	2.33–4	3–4.5	3.6–4.8	4	4
0	1–5	6	3–3.5	2.33–4	3–4.5	3.6–4.8	4	4	4–3.43	2.92–3.43	2.92–3	3	3	3
Sources	1–5	6	6–7	7–12	12–18	18–24	24	24	24	24–35	35–54	54–72	72	72

[a] Average number of administered units = 3.66.

Table 5.3b

UNITS OF ADMINISTRATIVE ORGANIZATION—HORIZONTAL SPECIALIZATION OF SECOND-ORDER VERTICAL CONTROL UNIT SUPPRESSED[a]

Levels of hierarchy										
3										1
2	1	1	1	1	1	1	1	1	1	6
1	6–7	7–8	8–9	9–10	10–11	11–12	12–13	13–14	14–15	4
0	4–3.71	3.71–3.88	3.88–4	4–4.6	4.6–4.73	4.73–4.83	4.83–4.92	4.92–5	5–5.66	3
Sources	24–26	26–31	31–36	36–46	46–52	52–58	58–64	64–70	70–85	72

[a] Average number of administered units = 7.25.

pressure should be reflected minimally by high administrative costs, and often by the attempts of lower-level administrators or even the general population of the society to induce such specialization.

For example, prior to 1901 the Ashanti state of West Africa was composed of nine originally autonomous chiefdoms and a number of subsequently incorporated communities (Fortes 1969:140). Thus the central Ashanti administrative organization was attempting to integrate in excess of nine subordinate units. This situation suggests high administrative costs and possible lower-level pressure for horizontal specialization of the central organization. In fact the Ashanti state was subject to attempts at secession and was maintained largely by the military power of the central Kumasi chiefdom (Fortes 1969:140).

A similar situation seems to have characterized the Bulamogi state of East Africa. In one period prior to British domination, the state consisted of nine territories administered by client–chiefs of the king and three princely areas over which the king exercised administrative control (Fallers 1965:134). Thus some twelve units were integrated, presumably at rather high cost. Again, as our model would predict, there were apparently frequent princely revolts (p. 136), which, interestingly enough, were often attributed to excessive tribute demands by the king (p. 143).

In an archeological example, Richard Blanton (personal communication, 1976) suggests that just prior to its collapse in about A.D. 900, the central administrative organization of Monte Alban in the valley of Oaxaca, Mexico, integrated some thirteen major territorial units within the city itself. Administrative control of areas outside the city may have increased this number. Blanton further suggests that the marked population increase noted in this period was related to increased labor demands in response to increasing taxation. Heavy taxation and eventual collapse of the system might then be related to the increasing costs of integration of an inefficiently large number of administrative units.

In contrast to these examples of system stress, the nineteenth-century Yoruba state of West Africa seems to have suffered from relatively little internal dissension. Administration of the state under the king was territorially divided among the capital and five provinces (Bascom 1969:29). Recall that the present model predicts that administration of six immediately subordinate sources is relatively cost efficient.

One should keep in mind that while integration of a large number of subordinate units by a single-unit, highest-order, vertical control mechanism may also simply indicate a rather low level of integration. Heavy tribute or taxation and attempts at revolt may be among the attributes useful in making a distinction between a high level of integration at high cost and a low level of integration of a larger than expected number of information sources.

The organization model presented here may be used to generate spatial as well as social and explicitly organizational predictions. One such spatial prediction deals with the territorial organization of societies without vertically specialized decision-making organizations. Most such ethnographically known societies are of hunters and gatherers.

Wilmsen (1973) and Wobst (1974) have considered various aspects of hunting-and-gathering group size and territorial organization. They both consider a hexagonal distribution of band territories to be most efficient in maximization of use of available resources and minimization of travel and boundary maintenance costs.

The number of band territories bordering on the territory of an individual band (contact number) may be taken as a rough index of territory shape. Thus if maximization of resource utilization and minimization of movement are primary determinants of hunting-and-gathering spatial organization, the average contact number for individual bands should be six.

Considerations of interband interaction may alter this expectation. One of the most theoretically important forms of interband interaction involves the operation of mating systems (Wobst 1974). If bands tend to be hexagonally distributed, individuals within a given band consider mate availability and a series of additional ecological variables in at least six surrounding band territories.

The organization model just presented suggests that integration of six sources is more efficiently undertaken through a specialized control mechanism of a sort that most hunters and gatherers lack. In the absence of such a control mechanism, there may be some selective pressure to maintain the number of sources monitored within efficient limits. Phrased in terms of the present case, there may be some selective pressure to minimize the average number of adjacent band territories.

Actual spatial distributions should reflect responses to major operative selective pressures. As just seen, resource utilization and movement considerations suggest that the mean band contact number should approximate six, with a range of variability on either side of this value. Integration considerations, on the other hand, suggest that mean band contact number should be less than six—the lower, the better. An optimizing response to these contradictory pressures might then involve maintenance of mean contact number at close to, but less than, six.

Wilmsen (1973:11) gives a mean contact number for 22 Northern Paiute bands of 5.4 and for 15 Southern Paiute bands of 5.5. Birdsell (1958:196–199) provides a mean contact number of 5.5 for 100 Australian tribes. Wobst (1974:154) cites a mean contact number of 5.67 for 31 groups of Eastern Sub-Arctic hunters. Note that in all of these cases, the mean

values are less than but close to six, suggesting that pressures involved in source integration operate in conjunction with those involved in resource utilization and movement minimization in the determination of the spatial organization of hunters and gatherers.

If there is pressure for maintenance of territorial contact number at a value of less than six in societies without specialized vertical control mechanisms, then we would expect the absence of such pressure in societies having such mechanisms. Consideration of minimization of movement and boundary costs might then select for a spatial distribution such that territorial contact numbers may more closely approximate 6.0. Few such contact numbers are available in the literature. Haggett's (1965:52) value of 6.21 for 100 Brazilian counties is most frequently cited. Two small groups of Chinese market areas illustrated by Skinner (1964:22,25) have mean contact numbers for completely bounded areas of 6.20 and 6.67 respectively. Smith (1972:6–7) cites a mean contact value of 5.93 for 127 Guatemalan townships.

Although the figures presented here are by no means conclusive, they do suggest systematic differences in territorial organization between societies lacking and societies having specialized vertical control mechanisms. The present model suggests that the cause for such differences may reside in selection for efficiency in monitoring and integration of organizational units that function as basic information sources.

PROBLEMS FOR FURTHER WORK

I hope that the latter portion of this chapter has indicated something of the variety of problems to which organization models might be applicable. Although the actual model just presented is crude in the extreme, it is an attempt to more rigorously examine critical information variable relationships in the development of decision-making organizations. Thus it has been possible to lend additional support to statements such as the following: "A new institution will appear only after some critical threshold in need for information-processing is reached; thus, evolution appears steplike [Flannery 1972:423]."

Further work along present lines should consider the implications of deviation from a number of assumptions made here. For example, it was assumed in this chapter that all sources generate equivalent information output and involve equivalent channel monitoring costs. There is every reason to believe, however, that sources produce differential information output both synchronically and diachronically. Further, even sources of equivalent output may involve information transfer over different dis-

tances, and thus differential monitoring costs. The principle of requisite variety suggests that additional system variability related to these factors will also select for increment in the complexity of societal-level, decision-making organizations.

Other factors that should be examined include the following: What are the implications of monitoring information sources that are critical to system decision making but do not constitute organizational units integrated within the system? Increment in such sources would primarily result in increment in channel-monitoring work and thus differentially select for vertical specialization in decision-making organizations. Such differential selection would alter details of the sequence of most efficient increase in organizational complexity projected in this chapter. Such alteration would probably directly involve problems of channel capacity not considered in the present model.

Irrespective of the merits of the present formulation, I would suggest that organization models have a sufficient generality of applicability to contribute to the integration of a large number of more special purpose models. Such integration is essential to the development of general theory in anthropology, without which the probability of success in the description and explanation of the operation of cultural systems is low indeed.

ACKNOWLEDGMENTS

This chapter was originally prepared for the Conference on Social Differentiation and Interaction sponsored by the Anthropology Graduate Organization of the State University of New York at Binghamton, and held in Binghamton April 2–3, 1976. In addition to the other participants in that conference, I would like to thank Robert McC. Adams, Daniel G. Bates, Richard E. Blanton, Gary Feinman, Stephen Kowalewski, Susan H. Lees, Burton Pasternak, John Pfeiffer, John D. Speth, and H. Martin Wobst for their helpful comments on various drafts of this chapter.

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chapter 6

Early Craft Specialization: An Example from the Balkan Chalcolithic

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Recent research on the part of several individuals and the appearance of useful syntheses (e.g., Tringham 1971) have provided the basic framework for the Neolithic–Chalcolithic development in the Balkan Peninsula. Thus, it is possible to pose specific types of questions of the existing data and to use these data to test propositions related to general theory. A specific example of the development of craft specialization is presented here and is related to the phenomena of prehistoric sociocultural growth and differentiation.

The area considered here is what may be called the eastern portion of the Balkan Peninsula. It is centered in the Maritsa Valley of central Bulgaria and includes northern Bulgaria and southern Romania to the north, southern Bulgaria and northeastern Greece to the south, and a small portion of eastern Yugoslavia to the west. This is essentially the area of the Boian–Gumelniţa, or Karanovo V–VI, culture of the Balkan Chalcolithic. This period is now dated (in the light of radiocarbon dating and calibration) to ca. 5000–3500 B.C. (Gimbutas 1973). It is no longer to be considered as a short, transitional period but as a distinct period for

Social Archeology:
Beyond Subsistence and Dating

ISBN 0-12-585150-2