ENERGY AND SOCIETY: A CONCEPTUAL MAPPING

A PRELIMINARY LITERATURE SURVEY

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Abstract

Energy and Society: A Conceptual Mapping
A Preliminary Literature Survey (Roger W. Clark, 1976)
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This literature survey relates energy to four broad categories of social research:

Part One: The Diffusion of Innovations

Part Two: Community Studies

Part III: Culture Contact Studies

Part IV: Energy and Society

The purpose of the report is twofold:

1. To provide a nonexhaustive literature overview for each of these four categories of social science research
2. To suggest how such research contributes to the study of energy-society interactions and how future research might be directed toward improving this developing body of knowledge.

PART ONE

The Diffusion of Innovations

Research on the diffusion of innovations is both massive and widespread. One author places the total number of published diffusion studies at 2000-plus (Warner, 1974); and diffusion research may be found in the diverse literatures of anthropology, sociology (rural and general), education, communication, economics, marketing, political science, geography, and psychology. Fortunately, Rogers and Shoemaker (1971) have simplified matters by constructing a typology of diffusion research (Table 1) which organizes over 6,000 generalizations found in this vast literature.

In this brief overview, I will first present, within the context of the typology shown in Table 1, some of the diffusion studies that have been reviewed for the current mapping project, and, in addition, will discuss their general implications for studying the energy-society interface. Secondly, I will consider a few of the problems and research needs that currently restrict the practical application of the many generalizations found in the diffusion literature. I will, lastly, present some of the regularities found in the diffusion process and will then speculate about their implications--abstract and otherwise--for understanding the interrelationships between energy and social change.

I. Literature Overview

The following discussion directs specific attention only to "types 1, 2, and 4", designated in the first column of Table 1. For a more

TABLE 1. Types of diffusion research analysis completed and possible. From Rogers and Shoemaker (1971: 73).

TYPE	DEPENDENT VARIABLE	INDEPENDENT VARIABLES	UNIT OF ANALYSIS	NUMBER AND PERCENTAGE OF GENERALIZATIONS OF THIS TYPE IN THE MSU DIFFUSION DOCUMENTS CENTER	CHAPTER IN THIS BOOK DEALING WITH THIS TYPE OF RESEARCH
1	Rate of adoption of an innovation in a social system	Attributes of innovations (e.g., complexity, compatibility, etc.) as perceived by members of a system	Innovations	82 (1.2%)	Chapter 4—Perceived Attributes of Innovations and Their Rate of Adoption
2	Rate of adoption of innovations in different social systems	System norms; characteristics of the social system (e.g., concentration of opinion leadership); change agent variables (e.g., their strategies of change); types of innovation-decisions	Social systems	159 (2.3%)	Some attention is given in Chapter 7—The Change Agent; and also Chapter 9—Collective Innovation-Decisions
3	Attributes of innovations as perceived by members of a social system (e.g., complexity, compatibility, etc.)	Innovativeness and other characteristics of members of a social system	Members of a social system	0*	Some attention is given in Chapter 4—Perceived Attributes of Innovations and Their Rate of Adoption
4	Innovativeness of members of a social system	Characteristics of members (e.g., cosmopolitaness); system norms and other system variables; communication channel usage	Members of a social system	3,974 (58.4%)	Chapter 5—Adopter Categories
5	Earliness of knowing about an innovation by members of a social system	Characteristics of members (e.g., cosmopolitaness); system norms and other system variables; communication usage	Members of a social system	301 (4.5%)	Chapter 3—The Innovation-Decision Process
6	Opinion leadership in diffusing innovations	Characteristics of members (e.g., cosmopolitaness); system norms and other system variables; communication channel usage	Members of a social system	220 (3.2%)	Chapter 6—Opinion Leadership and the Multi-Step Flow of Ideas
7	Communication channel use (e.g., whether mass media or interpersonal)	Innovativeness and other characteristics of members of a social system (e.g., cosmopolitaness); system norms; attributes of the innovations	Members of a system (or the innovation-decision)	458 (6.7%)	Chapter 7—The Change Agent; and Chapter 3—The Innovation-Decision Process
8	Consequences of the innovation	Characteristics of members and the nature of the social system	Members or social systems	16 (0.2%)	Chapter 10—Authority Innovation-Decisions and Organizational Change; and Chapter 11—Consequences of Innovations
Others				1,601 (23.5%)	
Total				6,811	

complete discussion of this typology, the interested reader is referred to Rogers and Shoemaker (1971). The purpose here is to synthesize the studies for which abstracts have been prepared and that are now available in the ISPS energy library; and the secondary intent is to link diffusion research to the study of energy and society.

Rate of Adoption in a Social System

There are at least two distinct subcategories found in Rogers' and Shoemaker's "type 1" studies. The first includes studies which select, as their independent variable, the congruence or compatibility of innovations with existing practices (Bradner and Kearl, 1964; Powell and Roseman, 1972) or community values (Fathi, 1965). These attributes are then used to explain the rate of adoption.

Rogers and Shoemaker (1971:351) indicate the number of studies which support or fail to support a generalization derived from such investigations:

The compatibility of a new idea, as perceived by members of a social system, is positively related to its rate of adoption (18 studies, or 67 percent, support; 9 studies do not support).

From this generalization, we might postulate that the compatibility of a new energy converter with existing practices or values may affect the rate of adoption. Adopting a middle-size automobile, for example, may be perceived by large-car owners as being more congruent with their prevailing values than adopting a small car or public transportation. Hence, the rate of adoption in the former case might be much faster than in the latter.

Studies that examine how general perceptions of an innovation affect its rate of adoption comprise the second subcategory. Kivlin and Fliegel (1967, 1968), for example, consider the influence of farmers' perceptions of how new equipment will affect the time and energy, general convenience, cost, and other factors related to the efficiency of farm operations. Havens (1965) finds that 16 selected variables (e.g., social status, attitude toward credit, and size of operation) are significantly related to adoption behavior only when a choice of whether or not to adopt is perceived. His variables, however, were not related to the rate of adoption when no choice other than adopting bulk milk tanks was perceived by the interviewed dairymen.

Rogers and Shoemaker (1971: 350-351) offer the following generalization:

The relative advantage of a new idea, as perceived by the members of a social system, is positively related to its rate of adoption (29 studies, or 67 percent, support; 14 studies do not support).

Adopting a mandatory 55 mph speed limit may leave no choice or perception of choice. Socioeconomic variables may, therefore, be ineffective in predicting the rate of adoption. But if the speed limit is optional, socioeconomic variables may indeed be very effective predictors of whether or not a person will drive at 55 mph--yet there is no evidence that indicates the same variables will be effective in different situations. The results of this kind of diffusion study may then be as multifarious as human perception.

Rate of Adoption in Different Social Systems

Fliegel, et al. (1968) compare the rate of adoption in different

social systems. Their data suggest that, among small-scale dairymen in Pennsylvania and Punjabi farmers in India, capital investment and the substitution of technology for human labor are disincentives to adoption. But because farmers' perceptions of innovations were also taken into account, the study might logically be placed in the previous category. Presumably, this is how Rogers and Shoemaker (1971) are able to identify over 6,000 generalizations when only about a third as many studies are cited in their bibliography.

In addition, Fliegel, et al., (1968) find that middle-scale dairy-men's adoption behavior and perceptions were essentially opposite that of small-scale Pennsylvanian and Punjabi dairymen. Sociocultural differences, then, may account for variable rates of adoption.

Rogers and Shoemaker (1971:347) generalize:

System effects may be as important in explaining individual innovativeness as such individual characteristics as education, cosmopolitaness, and so on (7 studies, or 100 percent, support).

Thus energy conserving technology may show completely opposite patterns of diffusion in different sociocultural systems.

Adopter Categories

As indicated in Table 1 (type 4), the majority (58%) of diffusion studies relate the characteristics of members of a social system to their patterns of adoption. Many items such as system norms, communication networks, value orientations, as well as standard socioeconomic variables (e.g., age, education, income, family size, and so on) are included as independent variables in this large grouping of diffusion studies. Also, typically, these various attributes are used to distinguish persons

tending to adopt an innovation very soon after its release ("early adopters" or "innovativeness") from those who adopt an innovation during the later stages of diffusion ("late adopters" or "laggards").

Thus Ramsey, et al., (1959) find that late adopters express values of "security" and "traditionalism"; Bose (1961) demonstrates that higher castes and levels of education are associated with early adoption; and Feaster (1968) correlates age, education, and level of living with innovativeness. Also prediction models are developed by Chattopadhyay and Pareek (1967) and Finley (1968). The former is notable for its prediction of multipractice adoption behavior, and the latter for its "configurational approach", whereby the sample to be predicted is continuously divided into smaller and smaller subsamples.

Some researchers are, however, more innovative. Reynolds (1971), for example, asserts that "awareness" is not the beginning of the diffusion process, as is traditionally assumed, because innovativeness is closely associated with the occurrence of certain problems that are precursors to "awareness." Thus adopters may be searching for a solution to their particular problem well before they become aware of an innovation, and Reynolds contends that this "problem-oriented" behavior may be an important factor in conceptualizing the diffusion process.

Still other studies are designed to prove that one category of variables is better than another in predicting adoption behavior. Moulik, et al., (1966) use self-ratings of economic motivations to predict the adoption of nitrogenous fertilizers. But the wife's "integrative-supportive" role is found to be more important than socioeconomic variables in predicting the technological competence of farm operators (Straus, 1960). Yevacaris (1960) shows that because political conflict

leads to the strengthening of social relationships and communication networks, it transcends socioeconomic variables in predicting the rate of diffusion. And Van den Ban (1960) demonstrates that social isolation is a more significant factor than are socioeconomic variables such as educational level, farm size, or net worth. Many studies of this kind are, of course, manifestations of the usual competition between specialized interests in adversary disciplines.

The use of mass media, authoritative, peer, and commercial communication networks is often associated with early adoption (Mason, 1964). Rogers and Beal (1958) and Beal and Rogers (1960) find that personal sources of information are the most important communication link in all stages of the adoption process.¹ And in their classical study of medical innovation, Coleman, et al., (1966) show that "individual variables" simply divide doctors into groups with differing propensities to adopt-- for example, older doctors were less likely to adopt a new prescription drug. But "variables of social integration" (i.e., mostly those having to do with the amount of connections between a doctor and various communication networks) separate doctors into categories that have differing probabilities of adoption: "isolated" doctors had fairly constant probabilities while "integrated" doctors had increasing probabilities as the use of a new prescription drug spread throughout the medical community.

Finally, in a very complete discussion of the diffusion process, Wilkening, et al., (1962) discard the disciplinary myopia normally found

¹ Rogers and Beal (1958) recognize five stages in the adoption process: awareness, information, application, trial, and adoption.

in adoption-innovation studies. Among other things, they examine the effects of resource constraints on the acceptance of recommended farm practices. They (1962:162) conclude: "These results support the argument that adoption of new techniques is affected by the relationship of resources and by the farmer's attitude toward his resources rather than the amount of specific resources available."

Surprisingly, Rogers and Shoemaker (1971) omit this truly unique diffusion study from their comprehensive literature review. Yet the findings of Wilkening, et al., (1962) suggest that a society's perception of resource constraints is more important than actual conditions in determining whether or not it adopts environmentally deleterious or wasteful innovations.

But, of course, this observation seems intuitively obvious: if, for example, members of a particular society believe that infinite growth is possible even though their principal energy resources are non-renewable and rapidly diminishing, it seems likely that they will continue adopting energy-inefficient technology and life-styles, which perpetuate growing levels of per capita consumption. But if the prevailing mythologies are more in line with reality, the emphasis will most likely be on energy conservation and the development of means to make use of renewable resources. Thus adoption of energy-efficient technologies may be resisted in the first instance--it is not "congruent" with prevailing values and practices--and wholeheartedly endorsed, and, therefore, easily adopted, in the second instance.

Rogers and Shoemaker (1971:352-376) develop many other generalizations that distinguish early adopters from late adopters. A copy of all of their generalizations as well as their extensive bibliography is

available in the ISPS energy library. As noted earlier, Table 1 depicts several other types of diffusion studies, but those will not be discussed here.

It should, however, be noted that "type 8--consequences of the innovation" has only 16 studies which fall into this category. Certainly, then, this area demands additional research if planners are to evaluate the adoption of alternative programs, policies, and practices. Such research needs will be examined in more detail in the following section, and because "type 8" includes culture contact and acculturation studies, I shall postpone a discussion of it until such literature is summarized in a subsequent overview.

But to summarize this brief literature overview, it seems evident that for every innovation and for every unique set of social circumstances including its concomitant values, perceptions, and attitudes, there will be slightly different pattern of adoption behavior. Yet regularities exist, but at a more abstract level of generalization than indicated by Rogers and Shoemaker (1971). These will be the topic of a later discussion.

Nonetheless, there remain many constraining variables-- socioeconomic and otherwise-- which have yet to be examined:

Again, not much is known in any systematic way.

One can observe, however, how resistance factors work when a spreading trait suddenly stops along a religious borderline or when the spread of a new crop dies off where soil is less suitable. A similar killing effect on the spread of new types of production has also resulted from the existence of a limitation on the market.

. . If a diffusional process fails to break through some area of resistance, this fact may sometimes create a shadow effect over a wider region, because the non-receptive area does not send out a stimulus for further adoption in the way it could have if the innovation had moved straight through. (Hägerstrand, 1968:177).

II. Problems and Research Needs

Although there seems to be no paucity of diffusion research, there is, nonetheless, very little consensus as to how the accumulating knowledge might be applied to solve actual problems. And while rural sociologists have intensively studied the diffusion of technical assistance given to American farmers, few have suggested how one might intervene to promote or restrict the diffusion of a desirable or undesirable innovation. Indeed, finding ways for predicting the "desirability" or "social impact" produced by a new innovation is a major barrier restricting the use of intervention techniques--if they were, in fact, available.

Hägerstrand (1968:177) notes that two methods of intervention present themselves--one refers to the pattern of communication and the other to the distribution of resistance to change:

It is probably not possible to influence the structure of communication in a society through outside action, and, therefore, the channels of spread must be taken as given. But knowledge about the preexisting matrix of links would be useful, because it would make it possible to choose points of introduction of desirable innovations at the most efficient centers of spread. One method for locating such centers is to try to follow the course of some earlier innovations.

But again, this assumes that one can assess the "desirability" or the physical and social impact of an innovation before it is introduced. Furthermore, the many other difficulties are exacerbated by the lack of standardized definitions (DeFleur, 1966), by the ethnocentric bias of most North American diffusion studies (Holden, 1972), and by the persistence of disciplinary parochialism (Warner, 1974).

Warner (1974:440) continues:

The need now is for researchers to recognize and acknowledge the contributions and the interests of each other's disciplines. While the payoff to interdisciplinary research would appear to be considerable, it is clear that individual scholars could improve their work simply by attempting some integration. Diffusion is not exclusively an economic phenomenon; nor is it purely sociological, nor political. . . . Indeed, it is precisely the interdisciplinary focus which reveals the gaping inadequacies--the deficiencies and errors-- in what is currently accepted as knowledge about the diffusion of innovations.

Another problem seems to be the lack of diffusion research at different levels of social aggregation. The overwhelming majority of studies cited by Rogers and Shoemaker (1971) use either the innovation or the individual members of a social system as their units of analysis. In one exception, Walker (1969) examines the diffusion of innovative legislation among American states; and in another--previously discussed by Paul Sommers (1976a)--companies within consumer-goods industries are the units of analysis (Nabseth and Ray, 1974). Obviously, if ERDA is interested in the diffusion of energy conserving technology within political units and private corporations, more studies like these should be funded.

In another memorandum, Paul Sommers (1976b) described the logistic curve found in the diffusion of most innovations. Warner (1974:436) notes that little attention has been given to the factors which establish the upper asymptotic limit (or equilibrium) value (K): "For Example, why do some innovations diffuse through only half of the prospective market ($K = 50\%$) and others diffuse throughout the entire market ($K = 100\%$)?" The determinants of K are, therefore, critical in predicting the impact of a given innovation, because they establish the extent to which change will occur.

Social, economic, cultural, or even biophysical factors may interact simultaneously, producing synergistic effects that restrict or constrain the diffusion process. If researchers could then establish criteria for determining K, the practical applicability would, by far, outweigh that of all the diffusion research to date. Thus, in contrast to the existing studies on the--probably infinite--casual variables determining the rate of diffusion, research on the factors that constrain adoption may be of much greater importance for improving the decision-making process. But, of course, limiting factors may also be infinitely variable and equally difficult to measure--yet this cannot be determined until research is conducted in the area. Assuredly, however, the availability of abundant energy supplies is one constraint that will be of increasing importance in the near future.

Finally, Holden(1972:464) cautions:

Perhaps because of the high level of agreement on the relationship between value orientations and the adoption of practices, many might assume that the same values would be uncovered in relationship to the adoption of other things. This assumption has not, to my knowledge, been tested. Do these values hold, for example, on items that are used, not

in production or in medicine, but largely for recreation, such as devices to play tape recordings in automobiles?

Clearly such considerations have implications for the adoption of, say, an energy conservation program that affects leisure behavior and other non-work related activities. Moreover, nobody seems to have studied the diffusion of a particular type of family structure, of the spread of certain land-use patterns, or of the diffusion of energy expensive lifestyles. These factors are, nevertheless, of considerably greater significance in establishing patterns of energy use than the diffusion of new farming practices, prescription drugs, bulk milk tanks and so on.

In summary, then, there remain numerous problems and research needs which presently limit the usefulness of diffusion studies in the study of energy and society. And the results of existing studies, while interesting, have very limited applicability for solving energy related problems. Few have studied intervention techniques, the social and physical impacts of innovations, diffusion at different levels of social aggregation, the constraints to diffusion, and the diffusion of non-work products or activities. Furthermore, there is no assurance that the same socioeconomic, cultural, or biophysical variables affecting adoption behavior in one instance will remain constant from one social system, innovation, or resource environment to the next.

III. Some Regularities and Speculations

That diffusion is a part of the more encompassing process of social change is generally recognized by most authors:

The process of social change consists of three sequential steps: (1) invention, (2) diffusion, and (3) consequences. Invention is the process by which new ideas are created or developed. Diffusion is the process by which these new ideas are communicated to members of a social system. Consequences are the changes that occur within a social system as a result of the adoption or rejection of the innovation. Change occurs when a new idea's use or rejection has an effect. Social change is, therefore, an effect of communication. (Rogers and Shoemaker, 1971:7).

Furthermore, Barnett (1953) contends that innovation is the basis of the even more encompassing process of cultural change. His image of the basic process involves the hybridization or cross referencing of two pre-existing patterns of experience. When the hybridization becomes embodied in shared language symbols and when similarities and differences with past experiences are noted, the resulting substitution or cross combination of unified patterns of experience eventually leads to new ideas, innovations, and, ultimately, cultural change.

Cultural change, social change, and the diffusion of innovations may thus be conceptualized as a hierarchy of interrelated processes--each reciprocally affecting the next, and always being related to, and finding

meaning in the passage of time. Surprisingly, it is at this level of abstraction where we find persisting regularities and, indeed, the most interesting and convincing empirical evidence supporting them.

In this final consideration of diffusion research, I will take a cursory look at some of these regularities and will then speculate on how they relate the two seemingly unrelated metaphors of "energy" and "society."

Social Change and Patterns of Diffusion

In perhaps the most recent and certainly one of the best syntheses of diffusion literature, Hamblin, et al., (1973:1) integrate "over 500 sets of data guaging diffusion, innovation, conflict, and development processes." From this analysis, they are able to mathematically describe persisting regularities found in many different studies of social change. They (1973:121-122) comment:

We have seen in previous chapters that the diffusion of all innovations--whether technological or social-- is governed by the same underlying processes. This we consider to be a very important discovery, for it ties together under a theory of diffusion the technological as well as the purely social aspects of change. The curve of diffusion is not a function of the type of innovation but of communication and the level of reinforcement.

Several different curves of diffusion and their necessary pre-conditions are identified. For example, the conditions necessary for a logistic adoption curve include the following:

1. the total number of possible adoptions is limited,
2. the adoptions are mediated by persuasive communication among the units of the social system, and
3. reinforcement for adoption is constant. (Hamblin, et al., 1973:204).

The first condition seems obvious enough: for the diffusion process to approach some upper asymptote, there must be a limit to the number of adoptions that can occur. The second condition describes the content of an individual's communication network: communication must not only be present, but also persuasive. Thus in Coleman's et al., (1966) study of drug diffusion, a necessary condition for a logistic increase in adoption is that persuasive influence be exerted by colleagues. And the final condition asserts that the attributes which reinforce adoption behavior (e.g., perceived values, efficiency, congruence, and so on) must remain constant during the diffusion process.

It is interesting to note, however, that this third condition is related to an additional variable: "The input of a constant level of reinforcement into a social system for an activity is isomorphic with a constant energy input into the general system." (Hamblin, et al., 1973: 199). This incongruous, i.e., nonsociological, statement apparently originated from Ludwig von Bertalanffy's "General Systems Theory." Bertalanffy (1950:136), who spent much of his life exploring isomorphic laws in science (i.e., identical laws that have evolved independently in the various branches of science), observed:

Not only are the general aspects and viewpoints alike in

different fields of science; we find also formally identical or isomorphic laws in completely different fields. This is a well-known fact in physics where the same differential equations apply, for example, to the flow of liquids, of heat, and of electric currents in a wire. But it appears that the significance of this fact, and the possibilities it opens in the fields outside physics, have hardly been considered.

Indeed, Bertalanffy's foresight had a major impact on the social sciences. As Hamblin, et al., (1973:57) note, James Coleman's "mathematical training made it possible to adapt the equations furnished by von Bertalanffy . . .[and] . . . his sociological background allowed him to make the epistemic jump to see that conditions specified by von Bertalanffy's general mathematical systems theory were isomorphic to the a priori conditions of binary cultural diffusion." Thus when using Bertalanffy's isomorphic laws in developing their mathematical theory of social change, Hamblin, et al., (1973:198-199) necessarily include energy as an independent variable affecting social adaption.

Energy and Society

Fred Cottrell's notion about adoption behavior in relation to an energy surplus is, perhaps, a reasonable vehicle for continuing this discussion. Cottrell (1955:11-12) defines surplus energy as "the energy available to man in excess of that expended to make energy available." For example, the amount of energy a farmer produces in excess of that required to feed his family and pay for labor, supplies, and machinery necessary for farm operation can be viewed as surplus energy.

Later, Cottrell (1955:31) relates his concept of surplus energy to adoption behavior: ". . . the presence of an energy surplus is favorable to the adoption of a converter that will enlarge that surplus."

Diffusion research generally supports Cottrell's hypothesis, because surplus energy seems necessary to form and maintain extensive communication networks which are typically correlated with adoption behavior.

There is, however, some indication that the relationship between surplus energy and adoption behavior is not as simple as Cottrell suggests. Wilkening, et al., (1962) find that the adoption of new farming techniques is affected by the farmer's attitude toward his resources rather than the actual amount of resources available. Thus traditional values (Chattopadhyaya and Pareek, 1967), perceptions (Kivlin and Fliegel, 1967), congruence of innovations with existing techniques (Brader and Kearl, 1967), as well as many other symbolic interactions affecting attitudes appear to be intervening variables between adoption behavior and surplus energy.

It seems likely, for example, that an isolated social system which has developed in the presence of a limited supply of available energy will increase the efficiency of its functional interrelationships by gradually forming highly structured normative mechanisms, and thus improve the survival of the system as a whole. As this hypothetical social system persists within a relatively stable cultural and biophysical environment, the homeostatic mechanisms necessary for survival may become, as Rappaport (1968) suggests, more deeply embedded in ritual, myth, and traditional values.

We may, therefore, expect this social-biophysical interaction to become increasingly stable with the passage of time and as long as its symbolic meanings accurately reflect conditions in the biophysical environment. We might then conclude that Hamblin's, et al., (1973) axiom of social adaptation is supported because the reinforcement for adoption is, in this example, reinforcement in a negative sense. That is, because very little surplus energy is available for reinforcing the adoption of new social-biophysical relationships, no change will occur if the amount of energy input to the system is, indeed, isomorphic with the level of reinforcement. Or as Cottrell (1955:31) concludes, "Where the energy available is only slightly in excess of that required for survival, any great variation in behavior among those situated in any one place is impossible."

Yet Bertrand's (1948) finding that the presence of an abundant supply of labor retards the adoption of machinery seems to contradict Cottrell's hypothesis that surplus energy is positively correlated with adoption behavior. Similarly, Wilkening, et al., (1962) find that intensity of land use as indicated by stocking rate (cows per acre) is positively associated with the adoption of all types of practices except laborsaving. But on the basis of the previous speculations, it is postulated that these apparent contradictions can be explained by the degree to which a social system has adapted to its energy environment. Thus the resistance to adopting a converter that would enlarge the energy surplus is explained by the fact that in both of these exceptions, the social-biophysical relationships are relatively stable, well adapted, and have persisted for at least two generations. But resistance was only temporary.

In most studies of recent farming practices in the United States, resistance to adopting new energy converters rarely occurs. Cottrell might argue that this is because an energy surplus has existed during the period in which farming has become highly mechanized. But, again, the explanation would seem more plausible if we take into account the intervening variables. American farmers, unlike shifting cultivators whose myths are not embodied in the industrial revolution, share a common myth: that a better life will be possible for their children, and that their own lives will be improved by technology. Although Gillete (1946) finds a negative relationship between adopting new technology and values of security and traditionalism, a strong desire to raise their standard of living exists even among those expressing values antithetical to adoption. Perhaps, then, rising expectations fueled by increasing levels of surplus energy displace values of security and traditionalism and thus engender the belief that one's future is not inexorably linked to a given set of resources.

Thus it seems that adoption behavior may be motivated more by the myth of surplus energy than by its reality. That is, a society's perception of its energy constraints may act as a homeostatic mechanism, whereby normative values limit behaviors which are acceptable within a given supply of renewable resources. But the exponential growth of technological advances in recent times may have distorted this regulatory mechanism: the question as to whether or not it is necessary for survival remains unanswered. Cottrell (1955:30-31) states that "the probability that a food-raising people will adopt a new converter seems to depend in considerable part upon their current ability to produce an energy surplus."

In times when energy surpluses seem infinite, we might add that the probability of adopting energy-inefficient technology seems more likely to depend upon their current trajectory of beliefs, collective myths, and dreams of the future.

In conclusion, then, Hamblin, et al., (1973) mathematically describe regularities found in the process of social change. Fred Cottrell (1955), on the other hand, verbally describes patterns of social change. Both, however, relate energy to social change: the first, indirectly, and the second, directly. The speculations presented here suggest that diffusion research generally corroborates and unites these two theoretical approaches. Furthermore, these concluding observations suggest that a society's symbolic relationship to its resource environment may be an important intervening variable affecting consumption behavior and the diffusion of innovations. Thus if we assume that an exponential growth of per capita energy consumption is not realistically possible, then, perhaps, a realignment of our prevailing myths may be necessary before the introduction of energy conservation policies can be successful.

PART TWO

Community Studies

Like diffusion studies, community studies are many and widespread. They differ markedly, however, in several respects. First, community studies rarely present basic population statistics and other numerical data to characterize the population under consideration. Secondly, the unit of analysis--"community"--lacks an agreed upon or commonly accepted definition. George Hiller (1955), for example, found 94 definitions of "community", and the list has undoubtedly grown since. Finally, the subjectivity of community studies makes them at once,

...some of the most appealing and infuriating products of modern sociology. They are appealing because they present in an easily accessible and readable way descriptions and analyses of the very stuff of sociology, the social organization of human beings; and infuriating because they are so idiosyncratic and diverse as to steadfastly resist most generalizations. (Bell and Newby, 1972:250.)

I shall not, in this review, derive yet another definition of community. Rather, in some instances, "community studies" will be viewed as those which use a particular method for obtaining social facts, whereby the "most important generalization, from which all else follows, is that community sociologists have usually gone, sometimes for only a short while, to live in their community." (Bell and Newby, 1972:55.) Such works are exemplified by the now classical studies of the Lynds' Middletown and Middletown in Transition, Lloyd Warner and his colleagues' observations of the Yankee City, Davis and the Gardners' Deep South, and Vidich and Bensman's Small

Town in Mass Society. And in other instances, studies that simply identify the "community" as their principal unit of analysis will be cited, even though the empirical information is the result of a single questionnaire rather than of the author's personal living experience in the community.

Fortunately, several good reviews and bibliographies of community studies are presently available. Bell and Newby's (1972) synthesis is perhaps the best and most recent introductory volume to the literature. Payne and Bailey (1967) provide a classified and annotated bibliography for the research of state agricultural experiment stations. Hiller (1955, 1972) supplies important criticisms, the most significant of which have just been outlined. Wilkinson (1972, 1974) develops a unified theory of community development, while Murdock and Sutton (1974) discuss community approaches in relation to "neo-ecology", i. e., the more recent and updated community concepts of human ecologists such as Hawley (1950).

In contrast to the previous literature overview, this brief discussion of community studies is organized quite differently. The first topic includes studies that examine general characteristics of community change. General documentations of change as well as the positive and negative correlates of change will be the foci for this discussion. Secondly, studies that examine community change with respect to energy related causes will then be considered. And this final section will be concluded by indicating research needs for the future. The intent is, again, not to provide an exhaustive review; rather it is to conceptually link the study of communities to the study of energy and society.

I. Community Change

Ferdinand Tonnies (1957) was perhaps the first to make explicit use of ideal types to symbolize the polar dichotomies found in community and society. Since his book, Gemeinschaft and Gesellschaft (Community and Society), was first published in 1887, it has continuously provided a common point of departure for hundreds of studies dealing with the community. As Bell and Newby (1972:23) note, "If there is a founding father of community, ...the label perhaps suits Ferdinand Tonnies more than any other individual."

Community change was characterized by Tonnies as a transition from gemeinschaft, wherein human relationships are intimate, clearly defined by ascriptive roles, and relatively constant, to gesellschaft, wherein relationships are impersonal and contractual. Thus the importance of kinship, neighborhood, and friendship ties (forming the basis of all virtue and morality in the community) is progressively weakened by the growth of less personal associations such as that found between management and labor.

Tonnies concepts have, of course, given impetus to classical sociological debate and theoretical development. And the use of typological dichotomies to describe social continua between rural and urban settings is, even today, a still popular legacy. But contemporary community studies generally refrain from following Tonnies example of relating community change to more abstract theoretical constructs. Perhaps this is fortunate; yet such inhibitions seem to have also constrained the discussion of persisting trends found in community change over long periods of time.

In fact, only a handful of longitudinal studies (i. e., covering a

period longer than a decade) of the community have even been published. Anderson, et al. (1956), for example, linked community change between 1926 and 1951 to the improvement of communication and transportation. Straus and Houton (1960) used content analysis of editorials found in the National 4-H Club News to document a significant decline in achievement values between 1924 and 1958. Young (1960) analyzed gravestones to develop longitudinal indices of value changes in two small Canadian communities. Such temporal analyses of change are, however, rare exceptions because of the inherent difficulties encountered in historical research, the available information often differing in quantity and quality for different periods in the course of community development.

Some authors intuit longitudinal trends by projecting cross-sectional observations and by piecing together historical recollections offered by older community residents. Rafferty (1973), for example, concluded that early settlement patterns in Ozark communities were determined by natural resources and cultural preferences, while more recent patterns were the result of the availability of reliable transportation. In a cross-cultural analysis, Frank and Young (1962) specified three steps found in the simultaneous internal and external elaboration of social organizations: local autonomy, representative external contacts, and interpenetration of community and national systems. Or, as exemplified by Fliegel (1965:280), some discuss their cross-sectional findings in terms of temporal trends by injecting Tonnies continuum: "Social approval of the giving of time and energy, or goods, has been largely a system maintenance mechanism of the pre-industrial, or gemeinschaft, society."

Correlates of Change

Ever since and probably even before Burgess (1952) presented his

concentric-zone hypothesis of city growth, distance from urban centers has been thought by many to be a major factor influencing change in rural communities. Willits, et al., (1974), for example, found that adherence to traditional values varies inversely to the distance from urban centers. Similarly, distance was found by Haga and Folse (1971) to be the most reliable predictor of respondents' answers to the question, "To what community do you feel you belong?" Taylor (1960) elaborated on this distance association by examining the decisions of new manufacturing industries to locate along the Connecticut Turnpike. Thus his findings indicate, as suggested by Barlowe's (1958:285) radial zone concept, that proximity to major highways as well as urban centers may be an additional correlate of community change.

Kammeyer (1962), however, found that population center size rather than distance had a much greater influence on community decision-making. And Harden (1960:211) concludes that in "...high population areas which are well organized with respect to transportation and communication, distance may no longer be as important as one would expect." Thus as rural areas become increasingly accessible, distance from urban centers may become a less significant correlate of community change.

Attitudinal variations, as in diffusion studies, have shown significant correlation with community change. Christiansen, et al. (1960) found that the principal reason given by farm and non-farm residents for favoring industrialization was the belief that it would favor the community standard of living. Participation in voluntary associations was found to be uniquely important in formulating farmers' attitudes toward changes in economic policies of the community (Morrison and Warner, 1971). And many

other attitudinal surveys confirm the general conclusions listed in the discussion of diffusion literature. Although "community" is listed as the basic unit of analysis, such approaches do not differ significantly from analogous diffusion studies--further elaboration will, therefore, not be repeated here.

Community Acceptance of Change

Clearly defined and well organized codes of conduct (norms) that exist within diverse yet well integrated social systems have been found to favor the rapid acceptance of community change. For example, contrary to Kammeyer's (1963) expectations, ethnically homogeneous communities displayed less opposition to high school redistricting than did heterogeneous communities. This result, he concluded, was a reflection of the greater degree of social integration found in the homogeneous community. Similarly, Fleigel (1969) found that a proliferation of formal organizations favored agricultural changes in Indian communities.

Such conclusions are supported and expanded by Harkness', et al., (1963) case study of policy changes in an American hospital. They (1963: 217) observe, "An organization can persist, expand, and change while actors within significant decision-making subsystems do not agree upon a major goal or purpose." This resiliency is explained, in part, by administrators' control over the means of resource allocation and by their ability to define independent goals within the tightly integrated hospital community.

Resistance to Change

Resistance to change is also characterized by well organized codes of conduct, but the difference seems to be in the social unit where change is introduced. That is, when the predominant social interactions and normative

structure exists at the small group level of friendship or kinship associations, resistance to change seems much stronger than when the predominant group bonding and normative structure functions to regulate exchanges between social roles, positions, or other much larger, symbolically united, social aggregations.

Straus (1969), for example, confirms the "kinship deterrent" theory by demonstrating that the greater the intensity of interaction among extended kinship units, the less the psycho-social predisposition to modernization. Furthermore, motivation for migration in response to community change seems to be largely controlled by the nature of the individuals dependence on the local community (Uhlenberg, 1973). Thus, if the individual is tightly bound to the community on the basis of friendship and kinship ties, there is less likelihood of migration to another community where adequate substitutes for such relationships are difficult to find. But if most social interaction and bonding occurs between social roles, whereby the individual is a part of and symbolically connected to a large social aggregate, adequate role substitutes might easily be found in other communities. And as the result, community change and migration may encounter little resistance.

In his analysis of the Dakota Indians, Photiadis touches on this balance between assimilation and resistance to external sources of community perturbation. He (1963:354) observes, "By studying the interaction with the outside system and the influence of this interaction on interaction patterns inside the system, one could obtain useful information on change and stability of these two social systems." From this it may be concluded, as Cole (1958) suggests, that resistance to change and community survival are more closely dependent on intra-community organization and socially sanctioned mechanisms for response than on the nature of the perturbation itself.

Finally, "agrarianism" and the traditionally associated values concerning the importance of family farming have persisted in spite of farm industrialization and substantial alterations in the tools and techniques of American farming. Rohrer (1970) asserts that this persistence is due to the fact that powerful agricultural organizations have made use of traditional ideological expressions to warrant their policy positions. This paradoxical relation found between prevailing myths and reality, seems analogous to my earlier discussion of a similar relationship with respect to surplus energy. And the association of agrarian attitudes with poor education (Flinn and Johnson, 1974) adds further support to Rohrer's speculations.

Summary

Community studies have given extensive attention to the correlates of change as well as to factors which resist or facilitate alterations in the structure and function of social processes within the community. This arbitrarily constructed organization of piecemeal findings should not, however, conceal the unique attribute of community studies: that they usually consider a multitude of interacting factors found in community social life, including power, class, elites, religion, politics, communication, volunteer organizations, friendship networks, and so on. Although I have, in this section, isolated specific findings, it should be recognized that these are but minor elements of much larger works.

Ruth Glass (1966:148) concluded that community studies are "the poor sociologist's substitute for the novel." Indeed, the topics covered in such "novels" seem endless and difficult to summarize. But the following section will, perhaps, more clearly portray the content of community studies and how they relate energy to society.

II. ENERGY AND THE STUDY OF COMMUNITIES

Energy, a metaphor encompassing the processes of mechanization, industrialization, technological advances, and so on, is clearly related to community change and development. But how does a change in energy conversion affect social bonding mechanisms which regulate exchanges at various levels of community interaction? Sexual, conjugal, familial, commensal, competitive, and altruistic exchanges, for example, involve differing norms which regulate human behavior. I have alluded to the importance of these different bonding mechanisms when discussing how the individual is tied to the community and how this link, in turn, influences the outcome of mechanization or other perturbations to the community social structure. How, then, does the introduction of a new energy converter, such as the tractor, alter these variable characteristics of social bonding, and in which cases will it produce a significant and predictable social impact?

Community studies do not, unfortunately, address themselves to these specific questions. Nonetheless, community sociologists provide vivid descriptions of the relation between community and technological change. Shifting from horse-drawn to tractor-drawn plows, for example, clearly illustrates the process of "mechanization" and its resulting effects on community social structure. In an early study of this process, Hamilton (1939) recognized the social impact of mechanized farming on what he called the "family-farm institution." Changes in technology, or in Cottrell's (1955) words, "energy converters", resulted in extensive human maladjustment. Thus in Hamilton's (1939) opinion, education, care of the aged, the dependent, and the unemployed, once provided by the family-farm institution,

were rapidly disappearing as mechanization reduced the number of persons and human tasks required to operate the family farm.

Therefore, general support is given to the conclusion that as farming becomes more self-sufficient with respect to human energy, major changes will occur in the rural labor force, life cycles of farming families, work/leisure ratios, and, ultimately, in the social fabric bonding the traditional farming community. Furthermore, as more and more work is accomplished by power equipment, the general farm laborer will continue to become less and less secure (Pedersen, 1954).

Community studies, then, provide important empirical descriptions which document the social effects wrought by technological advances. Therefore, this section will first present a sampling of community studies that discuss rural change in relation to mass society, transportation and communication, and industrialization. Future research needs will then be outlined in this concluding overview of community literature.

Rural Change and Mass Society

Most community sociologists agree that rural change is more the consequence of exogenous than endogenous forces. The surrounding "mass society", in contrast to innovation and other internal sources of change, is thus viewed as the source from which the bulk of community change emanates.

In a historical review of community change in Land's End Peninsula, England, Hilton (1961:381) conceptually unites the factors affecting community development such that "changes in any part of the [following] equation require balancing elsewhere":

Technology + Economy + Human Values = ENVIRONMENT
(Physical + Cultural).

Hilton notes that a change in technology, economic conditions, social organization, or human attitudes may serve to instigate a chain reaction throughout the entire socioeconomic structure. Without discussing the merits of Hilton's paradigm, we may nonetheless observe that such changes do, indeed, seem to originate as the result of contacts external to the community.

American community studies have made similar conclusions about the influence of mass society, and its changing technology, on community stability and change. As Bertrand (1954:174) concludes, "No one will dispute the statement that the impact of technology has accounted for many of the changes taking place in rural locality groups." Passin (1942), furthermore, associates the introduction of mechanical devices in agriculture with an increasing dependence on outside markets and with the disruption of cohesive forces uniting church, family, community, spirit, and the respect for authority. And Gillette (1946) finds that mechanization is the reason most frequently given for farm enlargement in North Dakota. Hilton's (1961) paradigm, then, is borne out in these illustrations, for a change in technology is clearly associated with a change in the physical and cultural environment.

In a study of farm families under stress between 1949 and 1962, Reeder and LeRay (1970:6) conclude that the effect of technological advance is manifested in four major ways:

. . . the area fails to integrate the new technology into existing occupations and industries; the area fails to provide alternative employment opportunities when old occupations and industries are obsolete; individuals in declining areas fail to move to places with expanding employment opportunities; and individuals fail to

change to new occupations.

Furthermore, the secondary and tertiary effects of any of these manifestations will also permeate the community social structure, resulting in additional impacts which are perhaps impossible to predict.

As Vidich and Bensman (1958:318) conclude:

If a sudden, negative and disastrous shift in the situation occurs, the defense mechanisms of the affected members of the community may not be able to accommodate to the strains placed upon the personality. A single event such as the collapse of farm prices or an inflationary trend could challenge a whole class of individuals whose life organization is based on similar illusions. But, since change for those who live through it and perceive it appears to occur slowly, new and unrecognized forms of personal illusion and institutional resolution of personal problems are an ever-recurrent possibility. For this reason bizarre forms of personality disorganization can occur in unexpected ways and at odd times in unexpected quarters. And for this reason, furthermore, the prediction of future events lies outside the scope of simple projection of present trends.

Vidich and Bensman (1958:6-10) provide, in addition, several illustrations of how changes in energy converters influence social change:

A railroad completed in 1834 and cutting through the heart of the village, stimulated commercial activity and increased the importance of Springdale Village; . . . new methods of agriculture--the plow, and horses instead of oxen as draft animals--made farming the chief economic enterprise of the community. More than five-sixths of the total acreage

was farmed by 1875. . . Due to soil exhaustion and the farmers' inability to adapt new machines and farming methods to the rolling hills of the area, general farming became outmoded and unprofitable in the latter part of the 19th century. . . The development of the mass-produced gasoline engine formed the basis around which social and economic reconstitution of Springdale took place. The automobile established an intimate social connection between Springdale and the outer world and provided new business and occupational opportunities in the form of gasoline stations, repair shops and road construction and maintenance.

Transportation and Communication

Thus, as Vidich and Bensman (1958) imply, of the many modes by which mass society affects rural communities, transportation and communication are perhaps the most significant. An increasing frequency of contact with mass society will, of course, enhance the probability for assimilating new technology, new codes of conduct, and new means for social interaction and organization. Therefore, it is not surprising that community studies frequently identify changes in transportation and communication as the key causal variables which increase the interdependence between rural and urban society.

In fact, Fuguitt (1963) identifies such combined changes as the reason that the rural community is nearly extinct. And as early as 1931, Bruce Melvin noted that rural dwellers were taking on more and more urban ways of life because of improved transportation and communication media. While more recently, Lindstrom, et al., (1959), Anderson (1961), and

Yoesting and Marshall (1969) observed that such changes significantly alter trade patterns and the use of service centers and other locales for community interaction. Thus the content, location, and frequency of intercommunity contact are substantially affected by improved roads (Gessaman and Sisler, 1976) and by the adoption of other transportation and communication innovations.

There is, of course, nothing really new about this conclusion. T. Lynn Smith (1933), for example, attributed the fundamental social changes taking place in Louisiana to the automobile and to the improvement of rural roads and highways. Smith also noted that, between 1901 and 1931, changes in transportation were having a significant impact on the incidence of farmers' trade centers, their structure and organization, and the interrelationships between them. So although the social effects of adopting new transportation and communication systems may vary, they are consistently shown to be significant variables related to community change.

Industrialization

Industrialization is yet another process involving the introduction and use of new energy converters; and, predictably, it too has been shown to affect community social structure. But unlike shifts in communication and transportation--with which it is closely correlated (Taylor, 1960)--industrialization has a direct effect on community immigration and emigration. For example, population and economic changes brought about by industrialization influenced the boundaries of six major social areas in Missouri (Lively and Gregory, 1948).

Mass society is seen by Bertrand (1966) as confronting the rural south through the processes of urbanization and industrialization. And in

an earlier study, Bertrand and Osborne (1959) noted that the principal effect of industrialization is an improvement in the personal income and level of living for community inhabitants. Yet, in Bertrand's several analyses, industrialization did not significantly alter social participation, the operation of schools and churches, or farming practices because the community was equipped with "predefinitions" for meeting the situation. Bertrand and Osborne (1960:390) explained.

Routine situations occur regularly in life and necessitate little or no change in behavior patterns. The individual, through societal experience, is equipped with predefinitions (rules on how to act derived from similar experience) for these types of situations [i.e., an influx of new industry].

This observation seems to support my earlier argument regarding the importance of where social bonding and the formation of community codes of conduct are most significant in uniting and integrating individuals and social units comprising the community's social system. Because little change in the normative structure is required (i.e., predefinitions exist for similar experiences) the Louisiana communities examined by Bertrand and Osborne (1959,1960) easily assimilate industrialization without major social disruption, maladjustment, or "anomie"--meaning the complete breakdown of normative order. But if community members had to restructure their traditional modes of social interaction and to relate to each other on the basis of new social roles, the influx of industry may be socially disruptive, indeed.

Furthermore, Anastasio (1960) concluded that any social change in the Porthaven, Washington community would have to come from the introduction of

industry and a concomitant influx of people from the outside to change the stratification system from primary to secondary relationships. At the time of this study, social differentiation was based on the "total personality." Hence, for a significant social impact to result from industrialization, Anastasio argued that social differentiation would have to shift from being based on the "total personality" to one being based on occupational roles, or other such symbolic regulators of social exchange.

Research Needs

Community studies have thus provided fertile intuitions for considering the connection between energy and society. In addition, the studies cited here add empirical support to the broad hypotheses of Fred Cottrell (1955). Yet like Cottrell, they fall short in fully specifying the core mechanisms and key interactions by which energy and society interrelate. Although community studies, as we have seen, clearly illustrate that a change in energy conversion produces a change in social interaction, few regularities can be gleaned from these descriptive analyses.

Of course, the difficulty in synthesizing a grand consensus is probably due largely to the fact that the common unit of analysis--i.e., community--does not, unfortunately, enjoy a commonly shared meaning. Indeed, it is difficult to compare and contrast analyses of community as an area of shared norms with community as a self sufficient geographic area, or, as the case may be, apples with oranges. The resolution of such "mechanical" problems should rate a high priority in the research future.

But these revisions should not be at the expense of the perceptive and holistic vision that community sociologists now have of their object of analysis, however it is defined. Hillery (1955) found 20 definitions that

identify community as a social unit possessing common ends, norms, and means. This generic definition, as Bell and Newby (1972) note, returns to the use of community as a conceptual term. Thus rural communities may be proper subsets of this more encompassing definition. But it is in rural America where most community research has been conducted.

Certainly, then, urban studies such as Gans' Urban Villagers qualify as community research and, in addition, illustrate the problems of conceptualizing society in terms of arbitrarily selected, theoretical, geographical, and methodological compartments. Thus, as in diffusion research, some inter and intra disciplinary cross-fertilization could only enhance the contributions made by community research in the future.

For more specific recommendations to be made, however, concise generalizations must be formulated in advance. But because such generalizations have remained illusive in this analysis, these few, nonspecific, suggestions will be all that is offered here.

Summary

Energy and the study of communities have had, as we have seen, a long history of association. Community sociologists consider mass society and its changing technologies, industries, communication and transportation networks, and other changes in primary energy converters to be key factors influencing community stability and change.

But because definitions and methodologies show considerable variation from one community study to the next, we are presently unable to describe, with any degree of confidence, specific mechanisms by which changes in energy conversion induce community change. Thus until persisting regularities about such relationships can be identified in more explicit terms, community studies will remain tantalizing, albeit inconclusive, confirmations of our deepest intuitions.

PART THREE

Culture Contact Studies

The definition of "culture contact" is straightforward: Spicer (1968) observed that it is simply the coming together of two societies with different cultural traditions. "Acculturation", on the other hand, refers to those changes set in motion by culture contact: "Acculturation comprehends those phenomena which result when groups of individuals having different cultures come into continuous contact, with subsequent changes in the original cultural patterns of either or both groups." (Redfield, et al., 1936:149)

Rather than limiting this discussion to those studies which actually use the term "culture contact", I have elected to review anthropological studies that consider, in essence, the same factors and processes, although they may be termed "acculturation", "cultural change", "modernization", and so on. In this way, I hope to provide a broader mapping of the anthropology literature than would be possible if the more constraining definition was applied. For this reason, the present analysis is less intensive than the foregoing discussions.

In the first section, I shall discuss, very briefly, studies which analyze cultural change. Then I shall review culture-contact studies that specifically address themselves to energy and society.

I. Cultural Change

The following discussion provides a chronological overview of a few of the major studies that have given theoretical consideration to cultural change.

Bronislaus Malinowski and his British colleagues were among the first anthropologists to systematically analyze cultural change.

Malinowski (1945-71) summarized their general consensus of opinion:

The ultimate reality in culture change thus hinges in the fact that corresponding institutions in two cultures satisfy analogous needs in different ways and with different techniques; but in the process they have to use the same human and natural resources: land, capital, labor, politically organized force, the impulses of human reproduction, and also the standardized emotions, values, and loyalties specific to each culture. This means that institutions cannot be replaced rapidly, piecemeal, and without considerable sacrifice on the part of the community which has engendered the change and is carrying it on. On either side of the bar we have the same demand for limited material resources and limited human energies.

Malinowski's summary, then, emphasizes the intermingling of social and biophysical forces which combine to produce cultural stability or change. During this same period--the 1940s--American anthropologists differed somewhat in that their emphasis was more on the social aspects of change, an emphasis which was more in line, perhaps, with the notions of classical European sociologists such as Tönnies.

For example, Redfield's influential study, The Folk Culture of Yucatan (1941), emphasized for the most part sociocultural effects of change. He outlined (1941:339) the folk-urban continuum, characterized by three specific transitions that "'go along with' lessening isolation and homogeneity:...disorganization of culture, secularization, and individualization." Redfield's contribution, then, is more descriptive of the social consequences of culture contact than it is of the root causes.

Concomitant with and following the works of Malinowski and Redfield, scores of field anthropologists combed the globe to study the few

remaining primitive cultures. Like community sociologists, these field anthropologists went to live in primitive communities and used informants and detailed observations to gather their empirical evidence. Lengthy descriptions by Hogbin (1939), Reed (1943), Burrows (1947), and Berndt and Berndt (1954), for example, documented the effects of contact between industrial and primitive societies. Technological advances, they generally concluded, produced changes in population/cropland ratios, farming techniques and cultigens, land tenure relationships, and so forth. And in turn, these changes altered social values, kinship roles, patterns of trade, sacred traditions, and other sociocultural variables.

While most of these descriptive studies were unanimous in lamenting the "loss of innocence" caused by Western civilization, Margaret Mead (1965:445) concluded otherwise:

. . . rapid change is not only possible, but may actually be very desirable, that instead of advocating slow partial changes, we should advocate that people who choose to practice a new technology or enter into drastically new kinds of economic relationships will do this more easily if they live in different houses, wear different clothes, and eat different or differently cooked food.

In addition, Mead's (1965) study represents one of the few diachronic studies to be found in the acculturation literature. Twenty-four years after she made her initial field investigations of Peri, a Manus community in the Admiralty Islands, she returned and gathered the information necessary for the 1929-1953 comparison. As Mead's conclusion indicates, the changes in Peri touched every level of social, cultural, and economic existence. But serious maladjustment was not evident because the entire community had evolved at the same time, thus reducing the amount of internal conflict and anomie.

More recently, good anthologies of culture contact studies, which examine change in Native American cultures, have been published by Spicer (1961) and Walker (1972). Garbarino, (1972:127) furthermore, provides a fairly typical conclusion that may be found in this general body of literature: "The most sharply defined and far reaching of the changes occurred in the development of the cattle economy in the erstwhile swampland. The new technology went hand-in-glove with the new political organization. . ."

II. Energy and Cultural Change

In recent years, anthropologists have suggested that culture adapts to environmental conditions. Carneiro (1968:551), for example, observes that, "Culture, a uniquely human attribute, is something which man interposes between himself and his environment in order to ensure his security and survival. As such, culture is adaptive." Such notions have been outlined in more detail in several works: by Steward (1955) when he founded "cultural ecology"; by Leslie White (1957) in his book The Evolution of Culture; and by White's students in their discussions of Evolution and Culture (Sahlins and Service, 1960) and of Cultural Evolutionism (Service, 1971).

These works symbolize the ecological and evolutionary direction that cultural anthropology has taken in the past thirty years. The role that energy plays in this "neoevolutionary" theory is discussed by Sheils (1972). I will, therefore, not repeat his careful analysis here--I mention these works merely to distinguish this major shift in anthropological thinking, one which has had a significant impact on the studies that I will discuss in this section.

Human Problems in Technological Change (Spicer, 1952) is perhaps the earliest collection of anthropological case studies that consider the

sociocultural effects of a changing energy environment. In this anthology, Sharp's (1952) paper, "Steel Axes for Stone-Age Australians", clearly illustrates the effects of adopting a new energy converter (the steel axe) on the aboriginal social structure of the Yir Yoront. Among the several effects were the lessening of women's and children's dependence on men, the weakening of trading partnerships between men in different tribes, a reduction in intertribal trading and ritual gatherings, and the socio-economic dominance of Europeans who were the suppliers of steel axes. Thus adopting a single, fairly simple, energy converter resulted in a major upheaval in the social equilibrium of the Yir Yoront.

Further evidence that technological devices, such as the hoe and axe or the oxen and plow, are integral factors to the maintenance of cultural equilibrium is provided by Lewis (1949). His comparative analysis of two distinct systems of cultural development illustrated that the location and type of land, land tenure system, tools, and work cycles combined to assure cultural persistence. Furthermore, these two cultural systems existed side-by-side, symbiotically exchanging the products of both cultures, while maintaining their individual identities.

Such interactions and exchanges may, if desired, be measured in flows of energy and nutrients. In this way, we may isolate Steward's (1955) "cultural core" wherein functional ties with the natural setting are most explicit, and in which the interdependency between cultural patterns and organism-environment relationships is most apparent and most crucial (Geertz, 1963:6-7). Thus Geertz (1963:8) argues.

If one empirically determines the constellation of cultural features which are most unequivocally related to the processes of energy

interchange between man and his surroundings in any given instance, one necessarily also determines which environmental features have primary relevance for the same process.¹

Geertz (1963:80-81) continues to describe the historical involution of Javanese agriculture whereby "those cultural patterns which, after having reached a definitive form, nonetheless fail to stabilize or transform themselves into a new pattern but rather continue to develop by becoming more internally complicated. . . ." However, his conclusions are founded on data which permit only gross levels of generalization.

Using a similar data base, "modernization" studies examine the socio-cultural effects of the industrial revolution (Poggie and Lynch, 1974). Although such studies should, perhaps, more properly be termed "editorials on the industrial revolution", they do, nevertheless, offer some interesting insights. Adams (1974:42). for example, argues:

Since culture is the specific concatenation of perceptible energy forms, that is, specific behavioral (and presumably also psychological) processes, or meanings, conjoining human beings who stand in some particular social relation with one another, it follows that a culture comes into being when there is such a concatenation of available energy. Since a great deal of what human beings do involves retaining consistency of meaning-with-forms for some particular set of people, specific cultures remain fairly consistent over some period of time.

¹ Geertz' idea of using energy as an index of culture-environment interaction opened the door to a new realm of bioenergetic studies, epitomized by Rappaport (1968, 1971), Lee (1969), and Parrick (1969). But because they do not deal specifically with the processes of cultural change, I shall reserve their discussion for the final part of this conceptual mapping.

This "energetic" definition of culture, therefore, implies that energy is the key to cultural adaptation and cultural evolution.

Several studies have examined the social effects which have resulted from changes in primitive transportation systems. In a study of the Blackfoot, Ewers (1972:254), for example, concludes that:

After the introduction of horses permitted the accumulation of property, social status came to depend less upon a man's physical and mental qualities and more upon the number and quality of his possessions. A class system began to develop in which there were rich, middle-class, and poor families, distinguished on the basis of their relative wealth or poverty in horses.

Similarly, Berreman (1972) concludes that shifting from the traditional bidarky, a one-man skin boat, to the large wooden dory severely altered basic hunting and fishing patterns in addition to the social structure of an Aleutian village. According to Berreman, the Aleuts no longer camp in family groups, and careful childhood training and tutoring was made unnecessary for learning the difficult skill of piloting a bidarky. Moreover, the authority of the village chief was diminished as was the Aleut's respect for individualism.

Finally, in an ecological study of the Skolt Lapps of northeastern Finland, Pelto (1973:177) confirms the hypothesis "that important technological innovations lead to de-localization and techno-economic differentiation within the community." The snowmobile, Pelto (1973:166-168) concludes, resulted in the growth of dependence on commercially distributed sources of energy (de-localization) and "techno-economic" differentiation, in which "the items of equipment that each individual or household must own or have

access to accomplish their food-getting and other subsistence activities" are the means for adaptation to the socio-physical environment.

Summary

Anthropologists have, within the past thirty years, treated energy as a key independent variable in the process of cultural change. The processes of acculturation, modernization, cultural adaptation and evolution seem dependent on the conversion of new forms of energy or on the more efficient use of available resources. An equilibrium between sociocultural forces and the biophysical environment may become temporarily established when components in either or both become well organized and integrated into the surrounding systems. But as conditions change, as they inevitably will, the adaptive strategies which are able to maintain or increase their control of energy resources assure cultural viability, persistence, and survival.

Unlike diffusion or community studies, culture contact studies consider changes in the observed phenomena in relation to the broader processes of evolution. But, presently, many of these assertions have yet to be supported by careful longitudinal analyses.

PART FOUR

Energy and Society

I have not, thus far in my conceptual mapping of energy and society, discussed the many works that are to be found in bibliographies such as those by Morrison (1975) or the Committee on Interior and Insular Affairs (1972). Nor have I covered material that has been previously available in the ISPS energy library.

In this final Part, I shall cover some of the more familiar literature which makes an explicit connection between energy and society. And yet I will remain eclectic in my synthesis. The items I select are perhaps most notable for the items I leave out. Indeed, the dependent variable underlying most of the previous discussion has been social change, and I have purposely chosen those studies which make specific mention of technology or, if you will, "energy converters" as primary forces driving social change and cultural evolution. I shall not deviate from my selective bias in this concluding discussion.

First, I will present some of the research needs which, heretofore, have not found their way into the discussion. They represent not a systematic attempt to "tie together" loose ends; rather, they are problems which in my opinion demand immediate attention. Secondly, I shall summarize the major points of this entire report by presenting them within the context of a theoretical construct--one which, I should add, relies heavily on "neo-evolutionary theory" (Sheils, 1972) as well as conceptualizations by such diverse persons as Edward O. Wilson, William F. Ogburn, and Lewis Mumford.

I. Research Needs

Two brief points will be made here: (1) that an interdisciplinary research effort is required before the problems of energy and society can be resolved, and (2) that current techniques for predicting future patterns of energy consumption, especially computer modeling techniques, are grossly inadequate for they fail to take into account the social factors which, to a large extent, shape our energy consumption behavior.

An Interdisciplinary Approach is Needed

Only recently have plant and animal ecologists come to grips with the complexities of making accurate energy measurements in open biological systems. But this has not been accomplished without considerable difficulty. When discussing energy and animal ecology, for example, Larry Slobodkin (1962:69) observed:

Precise measurement of energetic parameters is almost impossible and even rather crude measurements are time-consuming and expensive.

It must, therefore, be initially established that such measurements are of sufficient ecological significance to be worth our trouble.

Certainly, the same could be said today in reference to energy and human ecology. Since Slobodkin made this statement, works by Wilson (1968), Woodwell and Whittaker (1968), Odum and Pigeon (1970) and others have done much to resolve the problems of measuring energy flows in biological systems.

Unfortunately, however, these "nonsocial" scientists have faltered when suggesting how their knowledge might be applied to human society. In one rather embarrassing attempt, for example, H. T. Odum (1971) projects his profound knowledge of energy in nonhuman systems into the realms of economics, politics, and, ultimately, religion.

In another example, Woodwell and Hall (1973:52) suggest that "Perhaps we should examine in detail the possibilities of a more rational approach including the use of energy flux as a criterion in zoning." Their examples, however, show energy flux as measured in the entire biosphere. Yet not the slightest mention is made about the practical difficulties of determining energy flux as it occurs on a single piece of property or in the physical structures to be placed on it--much less on how such a policy could be implemented within the constraints of the existing political, economic, and social systems.

Fortunately, the more recent works of social scientists such as Gilliland (1975), Huffman and Fleming (1975), and Caldwell (1976) have made significant advances in resolving the difficulties found in the proposals of Woodwell and Hall. But these analyses also fall short. There are, for example, few longitudinal studies that trace how energy and society have interacted in the past and, moreover, how public policy and decision-making have either promoted or proscribed the adoption of new technology and energy consuming behavior. Without such knowledge of past trends and interactions, there can be little assurance that current proposals are, in fact, realistic solutions.

By combining the efforts of biologists and physicists with those of sociologists and economists, to name but a few of the many disciplinary perspectives required, energy resource problems may thus be attacked in a variety of ways. Multi-dimensional problems, of course, demand multi-dimensional solutions. Most scholars would agree that an integrated approach is desirable, and yet, very little progress has been made in this direction.

Predicting Future Patterns of Consumption

Energy modeling is a rapidly expanding practice among economists and

other interested professionals concerned with the problems of supply and demand. Searl (1973:7), for example, notes that a "recent study of the nature and extent of energy modeling efforts made for the Council of Environmental Quality revealed ninety-four energy 'modeling' efforts, of which about twenty were judged to be of special importance."

Energy modeling, of course, serves a necessary function, but it is not without its problems. Professional judgment is used in deciding what information is relevant, and best fit techniques used "because theory often does not tell us about the form of functional relationships." (Searl, 1973:8). Moreover, modeling may "gloss over" the all too important social variables which determine, to a large extent, the amount of energy a society demands.

For example, Darmstadter (1975) relies on aggregate economic and demographic variables to make his projections of future energy demands. But what happens when the correlation between these intervening variables change in relation to energy consumption? That is, if changes in demographic variables remained constant while per capita energy consumption increased in response, say, to the construction of energy-inefficient housing, then predictions made on the basis of such variables would be inaccurate. As Erickson (1975:12) cautions, there are two problems in using economic and demographic variables to project energy use:

1. the relationship between these variables and energy use may, in time, change rather abruptly so that even time series analysis fails to predict the change, and
2. forecasts of variables such as GNP may or may not actually be more reliable than forecasts of energy use directly.

Furthermore, Sam Schurr (1971:127-128) emphasizes the importance of social variables in determining the amount of energy that will be demanded in the future:

Energy consumption projections, based as they usually are on an examination of historical trends, are strongly influenced by the social factors that have molded demand growth in the past. Population growth, and such derivative factors as family formation and housing, are of considerable importance in setting the foundation from which many other factors influencing consumption emanate. . . .

These demographic and behavioral forces may well undergo changes in the future. . . . If these social underpinnings do indeed change, the effects on energy consumption could be of enormous importance.

Thus predicting future patterns of energy consumption will, by no means, be a simple task. But the present capabilities may be improved if consumption behavior could be linked to such social variables as life-style (Corr and MacLeod, 1975), family structure, shopping patterns, leisure behavior, and so forth.

II. Conclusion --

A Theoretical Synthesis

William F. Ogburn used four factors to explain the process of cultural evolution: invention, accumulation, diffusion, and adjustment.

"Invention," Ogburn ([1950]1964:23) defined as "a combination of existing and known elements of culture, material and/or nonmaterial, or a modification of one to form a new one." In a similar argument, Barnett (1953:18) noted that innovation takes place when there is an intimate linkage or fusion of two or more elements that have not been previously joined.

Hence, the uniting of two pre-existing "configurations"--mental activity systems (symbols) that are the counterparts of external referents-- stimulate or set in motion the process of cultural change. Because "culture contact" and "innovation" involve the coming together of two "configurations." both are sources of change: exogenous change in the former instance and endogenous in the latter.

"Accumulation," Ogburn ([1950] 1964:24) noted, "occurs when more new elements are added to the cultural base than are lost." As in the early stages of a logistic diffusion process, accumulation tends to grow exponentially and is the result of extensive interaction or communication of ideas within a particular culture or social system.

"Diffusion, the third factor in the process of social evolution, is an expression used by anthropologists in referring to the spread of inventions from one area to others, usually from the area of their origin. The spread of inventions is promoted by the various communication and transportation inventions." (Ogburn, [1950]1964:27). Community studies, as we have seen confirm this conclusion: recall that changes in transportation and communication systems were found to be key variables affecting community stability and change.

Finally, Ogburn ([1950]1964:29) noted that "Adjustment of one part of society to another is important in understanding the evolution of culture, for the parts of culture are intertwined in varying degrees." Adjustment, then, is the end result of invention, accumulation, and diffusion. It is the social impact. Adjustment, moreover, can be minor and inconsequential or it can rapidly dissolve social solidarity, bonding, and normative order.

Thus, Ogburn's concept of cultural evolution lends a theoretical perspective to and unites the fragmentary information presented in the earlier discussions. Diffusion studies examine how new ideas, inventions, and innovations spread within societies and throughout cultures. Community studies illustrate how social adjustments are made to various sources of perturbation: industrialization, mechanization, changes in transportation and communication networks, and so forth. And culture contact studies portray the entire process of cultural evolution by documenting the introduction, assimilation, and diffusion of high energy technology in primitive societies and by noting the often radical social adjustments which result.

Furthermore, the rate, efficiency, and kind of energy conversion has been found, in each of the previous discussions, to be directly related to sociocultural stability and change. And while these relationships have not been as well supported as we could have hoped, important similarities were found from one discipline, culture, and geographic region to the next. Energy affects the amount of communication and social interaction that is possible in the diffusion of innovations. Energy affects the human labor required to maintain the family farm, and the normative relationships on which it is sustained. The amount of surplus energy available to a rural community affects patterns of social participation and integration among its members. Energy is, furthermore, related to how we are individually bound to society, how we perceive our role in relation to others, and how our mental projections of the future are formulated and, in turn, affect our day-to-day behavior.

Such are the speculations and intuitions that may be gleaned from the literature. Unfortunately, we know very little about the specific nature of

these relationships other than that they seem to exist. Yet, these intuitions may be supported on a somewhat higher level of abstraction. For example, every social encounter involves the exchange of organized energy in the form of information about past experiences. That is, memory may be thought of as stored energy from which we select our response to external stimuli. As more experiences are shared by conspecifics, a greater reserve of information becomes available to each individual, and routine encounters may be approached with a greater degree of certainty. A clearly defined normative structure may evolve, and collective responses may be organized to fulfill common needs and thereby improve the efficiency by which resources are converted to usable forms. As this efficiency is improved, more time and human energy can be devoted to nonsubsistence activities or in developing new means for manipulating the biophysical environment for human benefit.

If resource limits are exceeded, knowledge about the adverse effects is also stored in the collective experience. Future consumption habits may then be modified, for the results of rapacious behavior are now more certain. And culture is the homeostatic mechanism for accumulating such information. As Wilson (1975:560) argues, "Culture, including the more resplendent manifestations of ritual and religion, can be interpreted as a hierarchical system of environmental tracking devices." Roy Rappaport's (1968) study of ritual among the Tsembaga, whereby ritual is highly adapted to the ecological constraints of New Guinea, adds further support to Wilson's conclusion. And as noted earlier, Wilson is by no means the first to conclude that culture is adaptive.

Ogburn (1922:117), for example, observed that:

It is probable that the social development of the future will be affected by changes in the quantity and nature of natural resources such as soil, minerals, forests, etc. The natural environment has always had an effect on the development of material culture, and very broad variations in geographical factors have been a conditioning element in the production of new cultural forms. So changes, shortages, or discoveries in natural resources will have an effect on the material culture of the future.

Later, Mumford (1934:375) applied Ogburn's notions and, in addition, cited energy as the principal resource to which culture is specifically attuned:

Conversion has to do with the utilization of the environment as a source of energy. . . This seizure of energy is the original source of all our gains: on a purely energetic interpretation of the process, all that happens after this is a dissipation of energy--a dissipation that may be retarded, that may be dammed up, that may be temporarily diverted by human ingenuity, but in the long run cannot be averted. All the permanent monuments of culture are attempts, by using more attenuated physical means of preserving and transmitting this energy, to avert the hour of ultimate extinction.

More recently, Fred Cottrell (1955:2) carefully outlines extensive historical evidence to support his central thesis:

The energy available to man limits what he can and influences what he will do . . . (while). . . the preservation of a system of values requires a continuous supply of energy equal to the demands imposed by that system of values . . . conversely changes in amount and form of energy available give rise to conditions likely to result in changes in values.

Later, Burch (1970) refines Cottrell's notions by relating the various levels of civilization to the predominant energy converter, resource system, social structure, and characteristic myth at various stages of development. And in pioneering studies of bioenergetic relationships found in primitive cultures, Rappaport (1968,1971) and Parrick (1971) construct energy budgets to analyze the interaction between humans and their resource environment. Thus energy provides a common unit for cross-cultural analysis, as well as a sensitive measure of human-biophysical interactions.

Furthermore, Richard Lee traces, from a primate baseline, the origin and evolution of human energy relations. Lee's (1971:48) analysis provides, in addition, an important conceptual connection between energy and the evolution of social bonding:

Whereas each adult non-human vertebrate organism is a self-sufficient subsistence unit, a large percentage of man's energy expenditure goes to feeding others, and a large percentage of an individual's consumption is of food produced by others. Thus for humans, the minimal self-sufficient subsistence unit includes at least a social group, such as family or 'band,' and at most includes economies involving hundreds of millions of persons.

The altruistic sharing of food energy may then be an important factor in the evolution of Homo sapiens and in the persistence of the modern family. Improving the efficiency of social interaction thus releases more and more energy for human consumption, for reproduction, and for developing yet further means to extract energy from the biophysical environment. But, of course, the process is constrained by the amount of entropy that the environment can withstand before its ability to fix the sun's radiant energy is impaired. Human social structure and the earth's capacity to fix free energy

are, therefore, interdependent and changes in one system induce changes in the other. Most of these speculations are based, as Sheils (1972) notes, in the "neoevolutionary" theories of persons such as Sahlins and Service (1960).

From these ideas, however, we might further speculate that improving the speed and efficiency by which innovations diffuse may be an adaption made as the result of a changing energy environment, especially when that change is manifested in expanding transportation and communication networks because both are directly related to the content and the amount of social interaction. Community studies, for example, frequently portray highly evolved means of social interaction, whereby altruistic and egocentric (competitive) forces produce a kind of dynamic equilibrium. That is, individual members in a community may, at times, pursue purely independent or innovative goals, while at other times, they may contribute to the efficiency by which the community extracts and distributes natural resources, which, to complete the cycle, permits the individual to be further released from those subsistence activities necessary for survival. Thus the community is efficiently organized and yet adaptive to changing conditions by promoting internal innovation and by enabling community members to interact with adjacent cultures. The latter instance, then, is illustrated by culture contact studies. When a highly evolved system (i.e. having control of energy resources far in excess of that necessary for survival) contacts a system having control of only the energy resources minimally necessary for survival, a rapid diffusion of labor-releasing technology frequently results and the recipient society must restructure its normative relationships accordingly. Diffusion, community, and culture contact studies, then, add plausibility

to both Ogburn's theory of cultural evolution and my own reconstructed version of neoevolutionary theory.

In conclusion, we have seen that the relationship between energy and society has been, historically, a recurring topic of discussion among rural sociologists, community sociologists, and cultural anthropologists. Such reactions remain, nevertheless, an undeveloped area of empirical research. I have found few persisting regularities about the specific nature of the relationship between energy and sociocultural change, and even fewer suggestions as to how such interactions may be predicted and controlled. Yet most agree that there is a fundamental relationship between the growth of human civilization and the means by which it extracts energy from the biophysical environment. This relationship then has been described by many but systematically analyzed by very few.

Therefore, it is perhaps fitting that I conclude this conceptual mapping by quoting one of the more lucid of these descriptions:

Like the social revolution that came inevitably to the farm when isolation ended, the technological revolution was so sudden and so complete that no one had time to consider what parts of it were good and which needed a little more thought. We bought hay choppers in the first place for the same reasons we go to the moon; we found out we could, and so we thought we must.

It all began so innocently. There have been tools for millions of years, and always an inexorable pressure to make them better, more efficient, more powerful. The effort made a quantum leap in my father's lifetime.

(Stadtfeld, 1972:154).

LITERATURE CITED

- Adams, Richard N.
1974 Harnessing technological development. In Rethinking modernization. Poggie and Lynch (ed.): 37-68. Greenwood Press, Westport.
- Anastasio, Angelo
1960 Porthaven: A changing north-western community. Washington State Coll. Agr. Exp. Sta. Bull. 616.
- Anderson, A. H.
1961 The expanding rural community: adjustment, problems, and opportunity. Neb. Agr. Exp. Sta. Bull. S.B. 464.
- Anderson, W. A. et al.
1956 Social change in Slaterville Springs- Brooktøndale Area of Thompkins County, New York 1926-51. New York (Cornell) Agr. Exp. Sta. Bull. 920.
- Barlowe, Raleigh
1958 Land Resource Economics. Prentice-Hall, Englewood Cliffs, N.J.
- Barnett, H. G.
1953 Innovation: the basis of cultural change. McGraw Hill, N. Y.
- Beal, G. M. and E. M. Rogers
1960 The adoption of two farm practices in a central Iowa community. Iowa Agr. Exp. Sta. Special Rept. 26.
- Bell, C. and H. Newby
1972 Community studies. Praeger, N. Y.
- Berndt, R. M. and C. H. Berndt
1954 Arnhem land. F. W. Chishire, Melbourne.
- Berreman, Gerald D.
1972 Effects of a technological change on an Aleutian village. In The emergent native Americans. D. E. Walker (ed.): 322-326. Boston, Little, Brown, Boston.
- Bertalanffy, Ludwig von
1950 An outline of general systems theory. The British Journal for the Philosophy of Science 1 (August): 134-165.
- Bertrand, Alvin L.
1948 The social processes and mechanization of southern agriculture systems. Rural Soc. 13 (1): 31-39.

- Bertrand, Alvin L.
1954 Rural locality groups: changing patterns, change factors, and implications. Rural Soc. 19 (2): 174-179
- Bertrand, Alvin L.
1966 The emerging rural south: a region under "confrontation" by mass society. Rural Soc. 31 (4): 449-457
- Bertrand, A. L. and H. W. Osborne
1959 Rural industrialization in a Louisiana community. Louisiana Agr. Exp. Sta. Bull. 524.
- Bertrand, A. L. and H. W. Osborne
1960 Road industrialization: a situational analysis. Rural Soc. 25 (4): 387-393.
- Bose, Priya
1961 Characteristics of farmers who adopt agriculture practices in Indian villages. Rural Soc. 26 (2): 138-145.
- Bradner, L. and B. Kearl
1964 Evaluation for congruence as a factor in adoption rate of innovations. Rural Soc. 29 (3): 288-303.
- Burch, William R., Jr.
1970 Resources and social structure: some conditons of stability and change. The Annals, 389 (May): 27-34.
- Burgess, Ernest W.
1925 The growth of the city. In The city, Robert E. Park, et al. Chap. II. Univ. of Chicago Press, Chicago.
- Burrows, Edwin G.
1947 Hawaiian Americans. Yale University Press. New Haven.
- Caldwell, Lynton K.
1976 Energy and the structure of social institutions. Human Ecology. 4 (1): 31-45.
- Carneiro, Robert L.
1968 Cultural adaptation, In International encyclopedia of the social sciences. D. L. Sills (ed.). Vol. 3:551-554 Crowell, Collier, and Macmillan. N. Y.
- Chattopadhyay, S. N. and U. Pareek.
1967 Prediction of multipractice adoption behavior from some psychological variables. Rural Soc. 32 (3): 324-333.
- Christiansen, J. R., et al.
1960 Industrialization and rural life in two central Utah counties. Utah Agr. Exp. Sta. Bull. 416.

- Cole, Lucy W.
1958 What is happening to rural neighborhoods? Mississippi Agr. Exp. Sta. Info. Sheet 598.
- Coleman, J. S., et al.
1966 Medical innovation; a diffusion study. Bobbs-Merrill, N.Y.
- Committee on Interior and Insular Affairs
1972 A supplemental bibliography of publications on energy. U. S. Senate, S. Res. 45A: Serial No. 92-29. U. S. Govt. Printing Office, Washington.
- Corr, M. and D. Macleod
1975 Home energy consumption as a function of life-style. In Human Welfare: the end use for power. Commoner, et al. (eds.): 119-141, Macmillan, N.Y.
- Cottrell, Fred
1955 Energy and society; the relation between energy, social change, and economic development. McGraw Hill, N.Y.
- Darmstadter, Joel
1975 Conserving energy. Resources for the future. Washington.
- DeFleur, Melvin L.
1966 Theories of mass communication. David McKay, N.Y.
- Erickson, Lee E.
1975 A review of forecasts for U.S. energy consumption in 1980 and 2000. In Human Welfare: the end use for power. Commoner, et al. (eds.): 1-28, Macmillan, N.Y.
- Ewers, John C.
1972 The influence of the horse on Blackfoot culture. In The emergent native Americans. D. E. Walker (ed.): 252-270. Boston, Little, Brown, Boston.
- Fathi, Asghar
1965 Leadership and resistance to change: a case from an underdeveloped area. Rural Soc. 30 (2): 204-212.
- Feaster, J. Gerald
1968 Measurement and determinants of innovativeness among primitive agriculturalists. Rural Soc. 33 (3) : 337-348.
- Finley, James R.
1968 Farm practice adoption: a predictive model. Rural Soc. 33 (1): 5-18.
- Flinn, W. L. and D. E. Johnson
1974 Agrarianism among Wisconsin farmers. Rural Soc. 39 (2): 187-204.

- Fliegel, Fredrick C.
1965 Differences in prestige standards and orientation to change in a traditional agricultural setting. Rural Soc. 30 (3): 278-290.
- Fliegel, Fredrick C.
1969 Community organization and acceptance of change in rural India. Rural Soc. 34 (2): 167-181.
- Fliegel, F. C., et al.
1968 A cross national comparison of farmers' perceptions of innovations as related to adoption behavior. Rural Soc. 33 (4): 437-449.
- Frank, W. and K. C. Young
1962 A sequence and direction of community growth: a cross cultural generalization. Rural Soc. 27 (4): 374-386.
- Fuguitt, Glenn V.
1963 The city and countryside. Rural Soc. 28 (3): 246-261.
- Garharino, Merwyn S.
1972 Big Cypress: a changing Seminole community. Holt, Rinehart, and Winston, N.Y.
- Geertz, Clifford
1963 Agricultural involution. University of California Press, Berkeley.
- Gessarman, P. H. and D. G. Sisler
1976 Highways, changing land use, and impacts on rural life. Growth and Change (April): 3-8
- Gillette, J. M.
1946 Farm enlargement in North Dakota: reasons and causes. Rural Soc. 11 (3): 253-269.
- Gilliland, Martha W.
1975 Energy analysis and public policy. Science 189 (4208): 1051-189
- Glass, Ruth
1966 Conflict in cities. In Conflict in society. Churchill, London
- Haga, W. J. and C. L. Folse
1971 Trade patterns and community identity. Rural Soc. 36 (1): 42-51.

Hägerstrand, Torsten

- 1968 The diffusion of innovations. In International encyclopedia of the social sciences, D. L. Sills (ed.) Vol. 4: 174-178. Crowell, Collier and Macmillan, N.Y.

Hamblin, R. L., et al.

- 1973 A mathematical theory of social change. John Wiley and Sons, N.Y.

Hamilton, C. Horace

- 1939 The social effects of recent trends in the mechanization of agriculture. Rural Soc. 4 (1): 3-19.

Harden, Warren R.

- 1960 Social and economic effects of community size. Rural Soc. 25 (2): 204-211.

Harkness, J. P., et al.

- 1963 Community and administrative control of the hospital in transition: a case study. Rural Soc. 28 (3): 217-237.

Havens, A. Eugene

- 1965 Increasing the effectiveness of predicting innovativeness. Rural Soc. 30 (2): 150-165.

Hawley, Amos

- 1950 Human ecology: a theory of community structure. Ronald Press, N.Y.

Hillery, G. A., Jr.

- 1955 Definitions of community. Rural Soc. 20 (2): 43-51.

Hillery, G. A., Jr.

- 1972 Selected issues in community theory. Rural Soc. 37 (4): 534-552.

Hilton, Norman

- 1961 Technology, economy, and society in a long-settled area. Rural Soc. 26 (4): 381-394.

Hogbin, Herbert I.

- 1939 Experiments in civilization. G Routledge and Sons, London

Holden, David E. W.

- 1972 Some unrecognized assumptions in research on the diffusion of innovations and adoption of practices. Rural Soc. 37 (3): 463-469.

Huffman, J. and D. Fleming

- 1975 Allocative and energetic implications of land use planning. Environmental Law. 5:476-513.

- Kammeyer, Kenneth
1962 A comparative study of decision making in rural communities. Rural Soc. 27 (3): 294-302
- Kammeyer, Kenneth C.
1963 Community homogeneity and decision making. Rural Soc. 28 (3): 238-245.
- Kivlin, J. E. and F. C. Fliegel
1967 Differential perceptions of innovations and rate of adoption. Rural Soc. 32 (1): 78-91.
- Kivlin, J. E. and F. C. Fliegel
1968 Orientations to agriculture: a factor analysis of farmers' perceptions of new practices. Rural Soc. 33(2): 128-140.
- Lee, Richard B.
1969 !Kung Bushmen subsistence: an input-output analysis. In Environment and cultural behavior. A. P. Vayda (ed.): 47-78 The Natural History Press, Garden City.
- Lewis, Oscar
1949 Plow culture and hoe culture--a study in contrasts. Rural Soc. 14 (2): 116-127.
- Lindstrom, D. E., et al.
1959 Changes in service centers for farmers in Champaign County, Illinois. Ill. Agr. Exp. Sta. Bull. RSM-30.
- Lively, C. E. and C. L. Gregory
1948 Rural social areas in Missouri. Missouri Agr. Exp. Sta. Bull. 414.
- Malinowski, Bronislaw
1945 The dynamics of culture change. Phyllis M. Kaberry (ed.) Yale University Press, New Haven.
- Mason, Robert G.
1964 The use of information sources in the process of adoption. Rural Soc. 29 (1): 40-52.
- Mead, Margaret
1965 New lives for old. W. Morrow, New York.
- Melvin, Bruce L.
1931 The sociology of a village and the surrounding territory. New York (Cornell) Agr. Exp. Sta. Bull. 523.
- Morrison, Denton E.
1975 Energy: A bibliography of social science and related literature. Garland Publishing Co., New York.

- Morrison, E. D. and W. K. Warner
1971 Correlates of farmers' attitudes toward public and private aspects of agricultural organization. Rural Soc. 36 (1): 5-19.
- Moulik, J. P., et al.
1966 Predictive values of some factors of adoption of nitro-
geneous fertilizers by North Indian farmers. Rural Soc.
31 (4): 467-477.
- Mumford, Lewis
1934 Technics and civilization. Harcourt, Brace and World, N.Y.
- Murdock, S. and W. A. Sutton, Jr.
1974 The new ecology and community theory: similarities,
differences, and convergences. Rural Soc. 39 (3):
319-333.
- Nabseth, L. and G. F. Ray, (eds.)
1974 The diffusion of new industrial processes; an inter-
national study. Cambridge Univ. Press, London.
- Odum, Howard T.
1971 Environment, power, and society. John Wiley and Sons, N.Y.
- Odum, H. T. and R. F. Pigeon (eds.)
1970 A tropical rain forest. Nat. Tech. Info. Service,
Springfield, Va.
- Ogburn, William F.
1964 On culture and social change. O. D. Duncan (ed.). The
University of Chicago Press, Chicago.
- Parrick, Dwain W.
1969 An approach to the bioenergetics of rural West Bengal.
In Environment and cultural behavior. A. P. Vayda (ed.):
29-46. The Natural History Press, Garden City.
- Passin, Herbert
1942 Culture change in southern Illinois. Rural Soc. 7 (3):
303-317.
- Payne, R. and W. Bailey
1967 The community: a classified, annotated bibliography.
Institute of Community and Area Development. Univ.
of Ga., Athens.
- Pelto, Pertti J.
1973 The snowmobile revolution: technological and social change
in the Arctic. Cummings Publishing Co., Menlo Park.

- Photiadis, John D.
1963 Critical examination of change programs in light of a system equilibrium. Rural Soc. 28 (4): 352-363.
- Pedersen, Harold A.
1954 Mechanized agriculture and the farm laborer. Rural Soc. 19 (2): 143-151.
- Poggie, J. J. and R. N. Lynch (ed.)
1974 Rethinking modernization. Greenwood Press, Westport.
- Powell, L. C. and C. C. Roseman
1972 An investigation of subprocesses of diffusion. Rural Soc. 37 (2): 221-227.
- Rafferty, Milton D.
1973 Population and settlement changes in two Ozark localities. Rural Soc. 38 (1): 46-56.
- Ramsey, C. E., et al.
1959 Values and the adoption of practices. Rural Soc. 24 (1): 35-47.
- Rappaport, Roy A.
1968 Pigs for the ancestors. Yale Univ. Press, New Haven.
- Rappaport, Roy A.
1971 The flow of energy in an agricultural society. Scientific American 224 (3): 116-132.
- Redfield, Robert
1941 The folk culture of Yucatan. University of Chicago Press, Chicago
- Redfield, Robert, et al.
1936 Outline for the study of acculturation. American Anthropologist New Series 38: 149-152.
- Reed, Stephen W.
1943 The making of modern New Guinea. The American Philosophical Society, Philadelphia.
- Reeder, W. W., and N. L. LeRay
1970 Farm families under stress: reactions to social change in St. Lawrence County, New York, 1949-1962. New York (Cornell) Agr. Exp. Sta. Bull. 1027.
- Reynolds, Fred D.
1971 Problem orientation: an emerging dimension of adoption research. Rural Soc. 36 (2): 215-218.
- Rogers, E. M. and G. M. Beal
1958 The importance of personal influences in the adaptian of technological changes. Social Forces 36(4): 329-335.

- Rogers, E. M. and F. F. Shoemaker
1971 The communication of innovations (2nd ed.). The Free Press, N.Y.
- Rohrer, Wayne C.
1970 Agrarianism and the social organization of U. S. agriculture: the concomitance of stability and change. Rural Soc. 35 (1): 5-14.
- Sahlins, Marshall D., and E. R. Service
1960 Evolution and culture. University of Michigan Press, Ann Arbor.
- Schurr, Sam H.
1971 Energy research needs, RFF, NSF-C644. Nat. Tech. Info. Service, Springfield, Va.
- Searl, Milton F, (ed.)
1973 Energy modeling. Resources for the Future, Washington.
- Service, E. R.
1971 Cultural evolutionism: theory and practice. Holt, Rinehart and Winston, N.Y.
- Sharp, Lauriston
1952 Steel axes for stone age Australians. In Human problems in technological change. E. H. Spicer (ed.): 69-92 Russell Sage Foundation, N. Y.
- Sheils, Dean
1972 The importance of agriculture from the perspective of neoevolutionary theory. Rural Soc. 37 (2): 167-188.
- Slobodkin, L. B.
1962 Energy and animal ecology. Advances in Ecological Research: 69-101.
- Smith, T. Lynn
1933 Farm trade centers in Louisiana, 1901-1931. Louisiana Agr. Exp. Sta. Bull. 234.
- Sommers, Paul
1976a The diffusion of innovations: theoretical progress and two possible studies. ISPS Mapping Project, Inter-Office Correspondence, Yale University, New Haven.
- Sommers, Paul
1976b Conservation (energy efficiency) and the diffusion of innovations. ISPS Mapping Project, Inter-Office Correspondence, Yale University, New Haven.

- Spicer, Edward H., (ed.)
1952 Human problems in technological change. Russell Sage Foundation, N. Y.
- Spicer, Edward H., (ed.)
1961 Perspectives in American Indian culture change. University of Chicago Press, Chicago.
- Spicer, Edward H.
1968 Acculturation. In International encyclopedia of the social sciences. D. L. Sills (ed.). Vol. 1: 21-27. Crowell Collier and Macmillan, N.Y.
- Stadtfield, Curtis K.
1972 From the land and back. Charles Scribner and Sons, N.Y.
- Steward, Julian H.
1955 Theory of culture change: The methodology of multilinear evolution. University of Illinois Press, Urbana.
- Straus, Murray A.
1960 Family role differentiation and technological change in farming. 25 (2): 218-228.
- Straus, Murray A.
1969 Social class and farm-city differences in interaction with kin in relation to societal modernization. Rural Soc. 34 (4): 476-495.
- Straus, M. A. and L. J. Houton
1960 Achievement, affiliation, and co-operation values as clues to trends in American rural society, 1924-1958. Rural Soc. 25(4): 394-403.
- Taylor, Paul
1960 New manufacturing and the Connecticut turnpike. Conn. (Storrs) Agr. Exp. Sta. Prog. Rept. 43.
- Tonnies, Ferdinand
1957 Community and society. Harper Torchbook, N.Y.
- Uhlenberg, Peter
1973 Noneconomic determinants of nonmigration: sociological considerations for migration theory. Rural Soc. 38 (3): 296-311.
- Van den Ban, A. W.
1960 Locality group differences in the adoption of new farm practices. Rural Soc. 25 (3): 308-320.

- Vidich, A. J. and J. Bensman
1958 Small town in mass society. Princeton Univ. Press,
Princeton, N.J.
- Walker, Deward E.
1972 The emergent native Americans. Little and Brown, Boston.
- Walker, Jack L.
1969 The diffusion of innovation among the American states.
Am. Polit. Sci. Rev. 63: 880-889.
- Warner, Kenneth E.
1974 The need for some innovative concepts of innovation: an
examination of research on the diffusion of innovations.
Policy Sciences 5:433-451.
- White, Leslie A.
1959 The evolution of culture. McGraw-Hill, N.Y.
- Wilkening, E. A., et al.
1962 Communication and acceptance of recommended farm practices
among dairy farmers in northern Victoria. Rural Soc.
27 (2): 116-197.
- Wilkinson, K. P.
1972 A field-theory perspective for community development.
Rural Soc. 37 (1): 43-52.
- Wilkinson, K. P.
1974 A behavioral approach to measurement and analysis of
community field structure. Rural Soc. 39 (2): 247-256.
- Willits, F. K., et al.
1974 The ecology of social traditionalism in rural hinterland.
Rural Soc. 39(3): 334-349.
- Wilson, Edward O.
1968 The ergonomics of caste in the social insects. American
Naturalist 102 (923): 41-66.
- Wilson, Edward O.
1975 Sociobiology. Belknap Press, Cambridge.
- Woodwell, G. M. and C. A. S. Hall
1971 The ecological effects of energy: a basis for policy in
regional planning. In Energy, environment and planning.
M. D. Goldberg (ed.): 50-58. Nat. Tech. Info. Svc.,
Springfield, Va.

- Woodwell, G. M. and R. H. Whittaker
1968 Primary production in terrestrial communities.
Amer. Zool., 8: 19-30.
- Yevacaris, Constantine A.
1970 Political conflict and the diffusion of innovations.
35 (4): 488-499.
- Yoesting, D. R. and D. G. Marshall
1969 Trade pattern changes of open-country residents.
Rural Soc. 34 (1): 85-91.
- Young, Frank W.
1960 Graveyards and social structure. Rural Soc. 25 (4):
446-447.