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TECHNOLOGY AND ANTHROPOLOGICAL THEORY

Conclusion

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In putting together this collection of papers we have become aware of two things. First, each of the cases is historically unique and interesting – they can all stand on their own without need for further interpretation. Second, these cases contain important clues and guidelines which point to a more general theory of technology and sociocultural change. They do not go far enough to allow us to frame up such a theory, but they provide the inductive impetus for relating these examples to the wider system of theory building in anthropology. In the first edition of this book we were not yet ready to elaborate even the outlines of such a theory, but the ensuing 15 years have given us plenty of new materials, as well as general growth in various aspects of theoretical social science. We can now offer a theoretical synthesis, and show how this synthesis can lead directly to the testing of specific hypotheses.

That technology is a key element in all human affairs, and especially in sociocultural change, has long been central to anthropological thinking (Barnett, 1953; Foster, 1973; Steward, 1956; White, 1959). Yet, after several collections of case materials on social change (Spicer, 1952; Paul, 1955; Niehoff, 1966; and the earlier edition of this book), and various other forays into the role of technology (for example, the growing number of studies of hydroelectric projects by applied researchers), we anthropologists have not put forth an explicit theoretical system. In part this reflects a continuing hesitation among social scientists to recognize in theoretical terms the ways that machines and other things made by humans dominate large sectors of our lives. To place technology in a central place within the social science theory smacks of “determinism,” or “mechanistic thinking,” and it appears to give some sort of overt approval to the activities of engineers, factory managers, and other “technocrats” whose work so clearly affects our lives.

A theory of technology and social or cultural change requires several elements. First of all, it requires an unambiguous definition of technology. We must have a clear and workable construct—something we can all recognize as “technology,” as distinct from other features of the sociocultural environment. Second, we must conceptualize change in a way that permits valid and repeatable observation (measurement). Third, a theory must have a *mechanism* that operates to link technology in a causal way to the elements, features, or sociocultural characteristics that are said to “change.”

TECHNOLOGY

In our theoretical system, technology consists of individual, particular *things*, physical observables. Since the general meaning has always focused on human products, we therefore define technology as “all those machines, devices, and other physical apparatuses made and used by humans for instrumental purposes, and the physical products of those machines and devices.” In this definition, the more or less inert products of machines, such as roads, bridges, dams, industrial waste, and buildings are included.

We all recognize that the use of machines and their products requires “knowledge,” “skills,” “capital investment,” and many other less tangible entities. This is not technology per se, but we can readily include these factors in the expression, “techno-social system.” If we were to include all those other cultural features in the definition of technology, most of our resulting theoretical

statements would be tautological. For example, if we were to include human technical skills as part of the definition of technology, then a statement such as “technological change modifies the hierarchy of skills of workers” becomes circular.

Exactly what do we mean by “change” in any system? What is “social change” as compared to “cultural change?” In our theoretical approach, social change refers to changes in the patterns of recurrent behaviors in human social interaction. On the other hand, cultural change refers to modification – loss, addition, or transformation – of values, beliefs, attitudes, or other ideational elements relating to behaviors in given societies. In other words, we reserve the term “culture” for the internal states through which people give meaning and interpretation to the observable behaviors and products of behavior. The “patterns of recurrent behaviors” in our definition of “social” refer particularly to observable regularities large enough to “make a difference” – patterns that can be aggregated into the stuff of general social evolution. In our definition, then, the gradual reduction in the agricultural work force in industrialized nations is a *social* change; the concomitant changes in peoples' attitudes and values toward rural life are *cultural* changes. We recognize that the two are always closely correlated. However, the two realms are different in their logical structures, and the methodologies for documenting changes are conceptually different.

A theory of technology and social change, then, should account for the evaluation of such patterns as those identified by 19th-century evolutionists as “savagery,” “barbarism,” and “civilization,” and by Tonnies as *gemeinschaft* vs. *gesellschaft*. Statements about technology and cultural change, by contrast, should focus attention on emotive, ideational responses. For example, they should account for the ways in which definitions and beliefs about sexuality change in Atlanta and Ankara in response to the availability of contraceptive pills. Culture change and evolution are also involved in the creation of the American Constitution and the Bill of Rights, and in other legislative enactments embodying the values and prescriptions of various states and nations.

A theory must have mechanisms that make the connections between different elements in any given system. The mechanisms should involve as little prior explanation as possible—they are given as axiomatic for purposes of this particular theoretical system. Such linking mechanisms are often “black boxes,” the contents of which are the domain of research by other disciplines. For example, until recent decades the theories of genetics (e.g., propositions involving the Hardy-Weinberg formula) assumed the presence of linking mechanisms called “genes” whose internal structures were assumed to operate in certain regular ways. It was not considered important for geneticists to do research on the genes themselves. Anthropologists differ in the degree to which they seek to open these black boxes, or linking mechanisms, for direct inspection. Psychological anthropology arose in response to the felt need to examine assumptions concerning the mechanisms whereby purported personality mechanisms were causally linked to broader cultural features.

The main linking mechanisms in our theoretical system are the following:

1. We assume the presence of human drives to optimize personal resources (money, culturally defined materials, and equivalents); access to sexual activity; and satisfaction of other basic physiological drives (for food, water, etc.). We are tempted to include a specific assumption about human drives to engage in conflict, including warfare, to satisfy these drives or needs, but if such drives exist at all, they are best subsumed under the quest for personal gain.
2. Concomitantly, we assume human drives to reduce risks to acceptable limits—in warfare, material acquisition, and in sexual encounters (e.g., reduce risks of pregnancy, venereal disease, etc.).
3. It is useful to postulate a drive to optimize the amount of new information or stimuli directly experienced. This tendency is thought to be involved in the human and animal aversion to sensory deprivation, boring repetition, as well as in the reaction to “too much novelty.”
4. A key mechanism for bringing about behavioral (social) change is the drive to reduce cognitive dissonance—the tendency to change values (e.g., in response to new technology) when new behaviors (in

response to new technologies) are no longer consonant with previously held values. This mechanism is presumed to operate, for example, when a farmer changes his economic activities, especially if those economic activities no longer produce sufficient income to maintain the standard of living that his family has come to value.

This short list of mechanisms is sufficient to give considerable face validity to many of the effects of technology described in our case materials. We note that these mechanisms appear to “belong” to the domain of the psychologists. Psychological researchers would, of course, modify and expand our list of mechanisms. However, we feel that those psychological mechanisms are sufficiently well known (though many aspects are still controversial) so that there is no need to explore these black boxes in this discussion. We must add, however, that a large series of supposedly *economic* mechanisms that some people would wish to add here are also based on these same axiomatic operators (e.g., the so-called “law of supply and demand”).

To restate these mechanisms within the scope of our theory of technology, we begin with the assumption that humans everywhere seek to maximize personal material resources and access to sexuality. At the same time, people try to keep their risks within acceptable levels. Since the dawn of human culture history, people have turned to tools and equipment to accomplish these ends. Most of human culture history is a chronicle of accumulated technological things used by people to increase their access to resources more efficiently. Of course, the development of more complicated tools has also been accompanied by inventions in social forms themselves. Humans do not live by technology alone.

We stress that the mechanisms postulated here do not involve any assumptions about “societal efficacy.” Gains of individuals might at times “benefit society;” but the connections are murky. When gasoline prices rise, people spend money to buy smaller cars, ostensibly to save energy (purchased with their own money). The energy costs of manufacturing a new car, however, are sufficiently great that they would buy a lifetime of gasoline for the car owner. In a similar vein, the choices of Lapland reindeer herders to buy snowmobiles seemed rational from an individual perspective, but their overall costs and side effects almost certainly produced a net loss from a societal point of view. We cannot stress sufficiently that there is no teleological implication whatsoever in our theory. Nor does the theory require any assumptions concerning the location or pattern of technological innovations. For practical purposes, it can be assumed that the technological innovations of interest are essentially random events.

Here is how our theory works. First, we assume that people never have unlimited access to resources or risk-free sex, or (least of all) risk-free warfare. Also, we humans cannot completely reduce the onerous burden of necessary tasks—plowing fields, disposing of garbage, typing manuscripts. One of the results of culture is to shape the myths and cognitive rewards that make rational and endurable the inadequacies of both technology and society in delivering the material and other rewards people crave.

Cultural myths are standardized values that are easily articulated. This accounts for the fact that people everywhere have little difficulty in rationalizing their behavior. Shortfalls in reaching material and other objectives can be explained and incorporated into larger configurations of explanation.

Differences in cultures, from the point of view of our theoretical system concerning technology, can be treated as random noise, because many different myths can be constructed to make meaningful the limitations of technologies and social systems in delivering satisfying amounts of material benefits, sexual contact and so on. Some cultures at a given level of technology may be prudish, others libertine; some cultures are warlike, others avoid armed conflict. Many geographic, ecological, and other factors account for these differences.

When behavior and values are mutually supportive, the result is cultural consonance (unusual in modern history)—a comfortable state for human beings, and one which people seek to prolong and enjoy. Perhaps some of the cultures that anthropologists have described as “harmonious” have been those in which this cultural consonance was prolonged, without intrusion of new technology to create dissonance.

In recent times the proliferation of new technology has apparently increased the ability of some individuals to maximize the things listed above in our primary assumptions. The availability of new

technologies, especially when they are relatively inexpensive to acquire, increases cognitive dissonance. People perceive that new technology could permit them to get things they want, but prevailing values, or high costs, prevent them from doing so. Frozen dinners make it possible for people to maximize personal gain and lower personal effort by taking meals at their own convenience. This challenges the values of "family integrity" embodied in the prevailing norms or myths about sitting down as a family group for an evening meal.

When serious dissonance exists between technological features and cultural beliefs plus prevailing myths, that dissonance can be reduced by redefining the external reality (giving up successful technologies), or by changing the internal realities (ideas, values, beliefs). Our theory does not specify how much dissonance people can or will tolerate before changing their value systems. This is a matter for empirical research.

In general, in the conflict between the material interests of individuals and their ideational! cultural values, ideology will lose in the long run. Recent history displays a litany of partially discarded, or greatly modified, ideologies that have had to give way in the face of the massive technological changes we refer to under the general label, "modernization." However, ideological forces can have great impact on the daily lives of people, and in many instances firmly held values and attitudes can persist with surprising tenacity in the face of seemingly overwhelming material (technological) pressures.

Cultural change brought about by technological change does not result in elimination of cultural norms/myths. Rather, there is a reshaping or redefinition of norms. Sometimes there is replacement, with new myths created in place of the old, rationalizing and explaining the newer behavioral patterns that have become "normal." In many cases, values and attitudes may have changed, yet the mythology is maintained that "nothing has fundamentally changed."

To put some of these pieces together in a theoretical system, we offer the following simplified diagram:

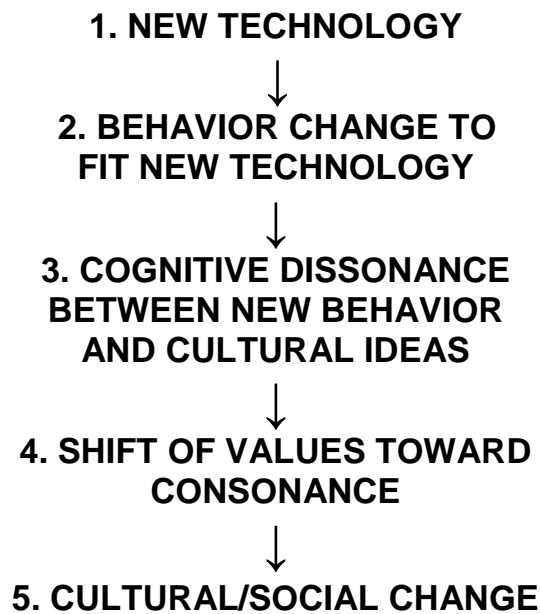


Figure 1

In Figure 1 we show the process as linear, for the sake of simplicity. In our complex world the system of causality must include an array of different factors at every point. For example, at point (2) the change in behavior is affected by social relations and by cultural values, as well as a complex of previously existing technological elements. Thus, specific hypotheses concerning any one of the nodes in our schema will require specification, or “controlling for” those other factors.

Researchers testing portions of the model should not be surprised when results in short-time perspective turn out quite differently from the predictions. The occasional example of workers in factories refusing to work with new machines is a familiar example of a short-time triumph of “culture” over the material pressures of technology. Equally familiar are the examples of individuals and groups totally rejecting new machines and equipment on ideological grounds (e.g., some Amish and other religious groups in the Midwest who do not drive automobiles). These instances do not negate the larger worldwide impact of the machines and other products.

DESCRIPTIVE PROPOSITIONS CONCERNING TECHNOLOGY

The theoretical system we are proposing here is based on a considerable mass of descriptive data, of which the cases in this book are a small fraction. The following propositions make up the descriptive foundations of the theory.

1. Over the past several million years of human inventiveness, the technologically controlled energy available per capita has increased from about 2,000 kilocalories to approximately 230,000 kilocalories per person. (Most of this increase in consumable energy came about in the past 200 years with the rise of controlled-combustion energy and then electrical and nuclear power.)
2. Two central aspects of technological evolution have been a) the gradual development of more and more effective means of transportation, and b) the increased speed of communication (information movement through telephone, radio, and computers).
3. However much dispute there may be over the issue of other aspects of cultural evolution, developments of more effective control of energy, faster transportation, and more efficient long-distance communications are all large-scale, unidirectional changes in human living conditions.

4. Technological inventions and developments beginning about 12,000 to 15,000 years ago have made it possible for humans to produce large amounts of food with progressively less and less direct inputs of human energy per unit of food produced. These changes, from the time of the Neolithic, have been closely associated with very large increases in human populations-which would not have been possible under the pre-Neolithic food-getting technologies.

TECHNOLOGY AND DELOCALIZATION

The large-scale changes encompassed in the primary effects of technological evolution include a progressive *delocalization* of sociocultural systems. Delocalization refers to the ever-increasing connectedness and interdependency of all human systems, through commercial exchange of goods, political/administrative systems, and other communications. Most of the cases in this book give clear illustrations of the sociocultural effects of delocalization. In rural Ugandan villages, people listen to the news and new cultural prescriptions emanating from the capital city and the wider world (Robbins and Kilbride); the Bikinians had earlier endured considerable intrusion from the wider world, but all that was nothing compared to the forced removal occasioned by the supposed need of the American military to test a nuclear device in that distant place (Kiste). The case of hybrid sorghum (DeWalt and Barkin) shows how food production technology, enmeshed in a system of transnational agribusiness, increases delocalization among Mexico's farming populations.

The unidirectional nature of basic technological evolution is matched by the unidirectional nature of sociocultural delocalization. It is possible that a massive nuclear conflict or other disaster *could* return the human survivors to a stone-age dependence on hand tools, low-energy farming, and small scale social life. Once such a disaster occurred, however, the same unidirectional evolution of technology and its impact would begin anew.

Two new cases in this book direct our attention to the latest phase of technological evolution. It appears for now that increased information processing capabilities, embodied in computers and robots, are gradually replacing increased efficiency of energy capture as the most important source of technological innovation. (It is not yet clear whether, in fact, efficiency in information storage and retrieval is directly associated with efficiency in energy capture. This hypothesis remains to be tested.) Of course energy capture is still prominent in new technology (solar technology, for example), but computerization of ordinary, everyday tasks appears to be an even stronger factor for social and cultural change in the last quarter of the 20th century.

GENERALIZATIONS FROM OUR CASES

In addition to the broad aspects of technological evolution reviewed here, our case materials point to a number of more specific hypotheses for research. Some of these include:

1. "Technological changes raise the capitalization costs of production systems, bringing about concomitant social differentiation and increased social inequality, particularly under conditions of free enterprise." This hypothesis is, of course, quite similar to many Marxist analyses, but does not arise from the same assumptions. Social differentiation from new technology is evident in the case of the snowmobiles in Lapland reindeer herding (Pelto and Muller-Wille); and the dynamics of farm production, discussed by DeWalt and Barkin in connection with hybrid sorghum, also point to increased social inequality in an already highly stratified society.

2. "Introduction of new technology brings about shifts in cognitive definitions of the older technology, even among persons who do not have direct contact with the new technology." This hypothesis is suggested by Roberts and Chick in their research on the machine shops in the Pittsburgh area (pp. 301-327). This hypothesis has far-reaching implications. If it proves to be supported in other research, this principle provides a mechanism to account for the seeming ease with which new technology is incorporated into preexisting cultural systems. Roberts and Chick suggest in this example that people make preparations for cognitive dissonance reduction in advance of behavioral changes. Support of this hypothesis would lead us to refine and modify our assumption (concerning cognitive dissonance) in the model above. Roberts and

Chick also suggest that the basic principle would apply in other situations besides those involving technology (religious systems, for example).

3. "New technological items are often perceived by individuals as labor-saving devices, and adopted for that reason, even though the net effect of their adoption does not include shorter hours or easier work." The example of the microcomputers (Evans and Bernard) is a clear illustration of this principle. The main use of microcomputers in the cases described in their paper, and in many journalistic accounts, has been for supposedly easier accomplishment of the regular, usual tasks of writing and organizing written materials. "Nothing new" comes about from the adoption of the technology for these purposes-until certain other technological and environmental modifications have had an impact on the sociocultural system.

4. "All technological features are enveloped in a web of nonobvious cognitive definitions, values, and other cultural accoutrements." Roberts and Chick demonstrate clearly that the people who work with the lathes, drill presses, and other equipment in machine shops have complex systems of expressive judgments concerning the machines. In other research, Roberts and associates have also demonstrated that people engage in complex expressive behaviors in the course of instrumental acts of machine use (Roberts, et al., 1972; Roberts, et al., 1980). A corollary of these principles becomes immediately apparent: "Users of specialized machines have complex cultural subsystems, relatively unknown to nonusers, concerning these technological items." This hypothesis might be of special importance in those many cases in which efficiency experts, managers, or other persons encounter unexpectedly serious opposition when they seek to change the sociocultural environment surrounding machine use.

5. "New technology brings new requirements in human skills and training, and usually results in social change as some types of persons are favored, and others handicapped, by the new skill/knowledge requirements." In the case of Ciudad Industrial in Mexico (Poggie), it appears that younger persons are much more likely to be selected for employment in the new factory complex. The snowmobile technology in Lapland also tended to favor the younger men, but it gave some previously unskilled persons a new way to enter the complex technical field of reindeer herding (Pelto and Muller-Wille). It is widely believed that the advent of microcomputers places older persons at a disadvantage in learning the new technology, but that direction of differentiation is far from absolute. The newest computer technology appears to include many features that could operate to simplify the skills/learning requirements for young and old alike.

6. "New, more complex social structures (increased hierarchical organization, greater centralization, complex interest groups, unions, etc.) arise whenever technological change substantially increases the per capita energy available, or increases the speed of transport and communication in a population." This is simply a restatement of Julian Steward's and others' hypotheses concerning "levels of sociocultural integration" (Adams, 1975; Cottrell, 1955; Fried, 1967; Steward, 1956).

7. "All significant technological innovations affect spatial arrangements of populations, leading to changes in social organization." This hypothesis arises from the fact that technology is physical, and has direct physical effects, hence, locational attributes. The most obvious is the effect of any new road on population movement. The impact of the automobile on urban-rural population distributions is a frequently cited example. Hydroelectric technology often results in forced removal of populations, with resulting realignments of social groups (Scudder and Colson). Construction of new factories, or other money-earning facilities, is always accompanied by shifts of population to better utilize the new opportunities. Sometimes entirely new urban centers are the result, as is the case with Ciudad Industrial (Poggie).

These are only a sample of hypotheses arising from our theoretical model. Anyone who carefully reviews the cases here will be able to identify other plausible hypotheses concerning the social and cultural effects of technology. Some of the most important new questions suggested by the current stage of technological evolution are in the arena of values and symbols. We believe that changes in values, and valued symbols, come about through the processes of dissonance reduction. But dissonance can be reduced by a wide variety of different cultural forms. What are the processes by which certain cultural forms become central, and others marginalized, in relation

to techno social change? Examples from recent medical technology are perhaps the most striking illustrations of situations where redefinition of values is practically mandatory. Technology for artificially prolonging the life of a dying person; technology for identifying the sex and abnormal genetic characteristics of unborn fetuses; and, most dramatically perhaps, the development of various organ transplants—all these mechanical innovations force cultural change because their use requires value-laden decisions by the users of the equipment. Other technological innovations are not usually so closely coupled to the system of cultural values and symbols.