A REAPPRAISAL OF THE ROLES OF TECHNOLOGY AND ORGANIZATION IN THE ORIGIN OF CIVILIZATION

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ABSTRACT

The view that technological advance was the prime cause of the early civilizations is examined and rejected. Instead, it is argued that civilization was an organizational solution to specific social and ecological problems. Even where technology gave an impetus to the rise of civilization, it can be shown that the tools or weapons involved were themselves developed in response to societal demands. Thus, the invention of the steam engine, which led to the Industrial Revolution, can be traced back to the need by feudal states in Europe to cope with a severe shortage of labor. This interpretation is presented, not as a repudiation of cultural materialism, but as an elaboration on it.

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February, 1973

THAT TECHNOLOGY is a major determinant of cultural evolution is a view widely held among anthropologists. Eleanor Leacock (1958:195), for example, has said that "the assumption basic to evolutionary thinking . . . is that the technological aspect of culture is fundamental." And Leslie A. White (1949a:378) has remarked that "the type of social organization, art, and philosophy of a given cultural system will be determined in form and in content by the underlying technology."

The primacy of technology has been affirmed, not only with regard to the evolution of culture in general, but of the origin of civilization in particular. Thus, Thorkild Jacobsen (1946:249) stated that "in Mesopotamia technological advance seems responsible for creating the conditions of leisure, intimate intercourse of many individuals, and general material well-being, which stimulated the elaboration of a simple culture to a civilization."

For a number of years I, too, accepted this view of how civilization began. Recently, though, I have come to question it. It now seems to me that the origin of civilization can be better understood as an organizational response to certain ecological problems than as the result of advances in technology.

The belief that, in accounting for civilization, the role of technology has been overstressed and that of organization slighted is, of course, not original with me. Robert J. Braidwood, for one, expressed it at least 20 yr ago. In arguing against the view of V. Gordon Childe that the advance from Neolithic villages to urban civilization involved a technical revolution, Braidwood (1952:42) wrote: "We do not interpret the evidence in this way. The great change between pre-civilization and civilized human life came in those realms of culture other than the technological."

More recently, the same view has been expressed even more clearly by Braidwood's colleague, Robert McC. Adams. Writing in *The evolution of urban society*, Adams (1966:12) stated that "the available evidence supports the conclusion that the transformation at the core of the Urban Revolution lay in the realm of social organization. . . . it seems to have been primarily changes in social institutions that precipitated changes in technology, subsistence and other aspects [of culture] . . . rather than vice versa."

William T. Sanders and Barbara J. Price (1968:9) have made the same point in *Mesoamerica, the evolution of a civilization*. "Much of what is generally considered under the rubric of 'technology' by anthropologists," they write, "seems rather to be the effect, the product, of types

of societies, rather than their cause. Monumental public architecture [for example], a traditional hallmark of what is termed civilization, is clearly the result of a particular institutional order."

Here and there in their writings, then, a number of archaeologists have questioned the common tendency to ascribe to technology a predominant role in the rise of civilization. So far as I know, however, the issue has yet to be formally raised or fully aired in print, and in this paper I hope to make a start in that direction.

EARLY CIVILIZATIONS AND THEIR TECHNOLOGICAL BASES

In an earlier paper (Carneiro 1970a), I proposed a theory of the origin of the state which, by a slight extension, applies to the origin of civilization as well. Briefly, the theory holds that states first arose in areas of circumscribed agricultural land when increasing population pressure led to wars of conquest. In circumscribed environments, defeated peoples had nowhere to flee, and so were subject to incorporation into the political unit of the victor. The way in which militarily successful societies organized themselves to wage war and to administer conquered peoples and territory became the nucleus of state organization.

Technical advances often accompanied state formation. Thus, as those states located in arid regions grew in population density, large-scale irrigation systems were devised to help meet the increasing demand for food (Carneiro 1958). Nonetheless, irrigation cannot be regarded as a technical invention pure and simple. It did not depend on the existence of special tools, nor on the mastery of complex mechanical principles. Rather, it depended on the problem posed by a shortage of land, and on the organization required to mobilize masses of people and put them to work.

A labor force of the requisite size and organization is not to be found in autonomous villages. Only after village autonomy has been transcended and multi-village states created does it come into being. The transcending of village autonomy came about, as I have argued, through repeated and successful participation in war, rather than through any technological advance.

During the course of evolution, some states continued to grow and eventually developed into civilizations. The diagnostic feature of civilizations is the presence of cities. Cities are large centers of settlement where persons divorced from subsistence carry out such specialized functions as administration, production, exchange, and religious ceremonialism. Cities are also characterized by monumental architecture—including temples, palaces, and other public buildings. These aspects of civilization, however, are *adjuncts* of a large and highly centralized society, rather than preconditions for it. They develop as a response to population concentration. Indeed, it is not too fanciful to say that a civilized state generates monumental architecture the way a colony of polyps generates a coral reef.

As evidence of this contention, one can cite the fact that the impressive monuments of early civilizations were sometimes produced with the relatively simple tools of a Neolithic technology. Mesoamerica affords the most striking example of this. Thus, Robert Wauchope (1966:22) has noted that "native technology [in Middle America] changed in scarcely a single small detail from Formative times to the sixteenth century." And speaking of the Maya specifically, Grahame Clark (1970:82) has observed that "for all the monumentality of their architecture, their calendrical virtuosity, and their script—[they] still relied on stone as the basis of their technology." Or again, Sanders and Price (1968:10-11) have noted that while "most of the principal cutting tools were [of] stone . . . in terms of social complexity, it is more apt to compare sixteenth-century Mesoamerica not to the Neolithic of the Old World, but to its Bronze Age."

An inkling of how the Aztecs were able to produce imposing architecture despite a simple technology is provided by one of the early Spanish chroniclers, Fray Motolinía (1956:18). Motolinía, who actually saw the Aztecs at work, wrote: "They carry all materials on their backs.

Large beams and stones they drag by means of ropes, and since they were short on ingenuity but long on manpower, the stone or beam which could be carried by a hundred men, was carried by four hundred." A large labor force, directed from above, was the answer.

A similar passage from the writings of Cieza de León (1959:176) suggests that Inca civilization was built on the same basis: "The most amazing thing is how few tools and instruments they have for their work, and how easily they produce things of finest quality. . . . They also make statues and other large things, and in many places it is clear that they have carved them with no other tools than stones and their great wit."

THE POSITIONS OF CHILDE AND WHITE

V. Gordon Childe is generally considered the leading spokesman for technological determinism among archaeologists. Nevertheless, in his article "Archaeological ages as technological stages," Childe qualified this view: "The mere knowledge of bronze, the smith's presence alone, did not of itself produce even new tool types, nor enlarge social productivity by [means of] saws, wheeled vehicles or metal sickles. Iron of itself does not draw men on to fresh devices" (1944:21-23). Because of this absence of a strict one-to-one relationship between technology and economic organization, Childe (1944:23) suggested that "a classification [of archaeological stages] based on the property relations within which tools were used might be more significant" than the existing classification, based on technology alone.

However, while he considered such a new classification to be theoretically sound, Childe felt it necessary to cite, as a practical impediment to its use, the fact that "the archaeological record is, to put it mildly, vague as to the social organization of preliterate communities" (1944:23). Noting the anomaly that "by the accepted [sociopolitical] criteria, the Celts and Germans were . . . barbarians in the Early Iron Age . . . while the Bronze Age Sumerians were . . . civilized" (1944:23), Childe claimed that this disparity between technological and social attainments was justification for using the traditional system of archaeological classification based entirely on tool types. Why so? Because, Childe argued, the traditional classification "does permit us to detect just those contradictions between material forces of production and the relations of production on which Marxism lays such stress."

This statement sounds to me as if Childe were trying to make a virtue out of a shortcoming. Nevertheless, it shows that a foremost advocate of technological determinism recognized the possibility of a substantial discrepancy between level of technology and degree of sociopolitical development. This, of course, opens the door to the further possibility that factors other than technology have played a key role in this development.

The other great spokesman for technological determinism among modern anthropologists is Leslie A. White. White has repeatedly stressed that of paramount importance in a society's technology is the extent to which it utilizes energy. Indeed, he has made control of energy the major driving force in the evolution of culture. And this relationship he has formulated into a law: *"culture evolves as the amount of energy harnessed per capita per year is increased, or as the efficiency of the instrumental means of putting the energy to work is increased"* (White 1949b:368-369).

Do the arguments I have raised here bear on White's law? The answer is yes. Do they lead me to conclude that White's law is false? No; the law is true. Culture *does* evolve as the amount of energy harnessed per capita per year is increased. But the *converse* of White's law is *not* true. At least it is not *necessarily* or *always* true. Cultures can and do evolve without harnessing additional amounts of energy per capita per year, and without improving the tools by means of which they put this energy to work. I shall attempt to demonstrate this.

The realization that the converse of White's law does not hold first struck me several years ago when I compared the Kuikuru Indians of Brazil with the Aztecs of Mexico in terms of energy utilization.

The Aztecs were much more advanced than the Kuikuru. This is not a subjective conclusion on my part, but a fact, indicated by the difference in their scores on the Index of Cultural Accumulation (Carneiro 1970b:846). On this index, the score for the Aztecs is 303; for the Kuikuru 19. However, if we compare the Kuikuru and the Aztecs with regard to the amount of energy harnessed per capita per year, we find that the 2 are essentially the same. The Kuikuru had the muscles of their own bodies, supplemented by fire, as their only sources of energy. The same is true for the Aztecs. In neither case were there draft or pack animals to add to the energy sources.

How, then, was it possible for Aztec cultural development to have outstripped that of the Kuikuru by so wide a margin? The answer is not hard to find. The Kuikuru comprise a single village, small and self-contained, having a labor force of some 40 men. Political control by the headman is minimal, and economic specialization is limited to a few part-time specialists. The Aztecs, on the other hand, had aggregated many chiefdoms and states into a large empire numbering in the millions of persons. The labor force at the command of the Aztec rulers was therefore huge, and their control over it firm. The amount of production that could be extracted from this labor force applied was thus enormous. Moreover, so effectively was labor in subsistence efforts that a large part of the work force could be divorced from food production and reallocated to a great variety of specialized arts and crafts, occupations and professions–in short, to "culture building."

To be sure, the Aztecs possessed certain tools, weapons, and utensils which the Kuikuru lacked, but the tool kits of both were still basically Neolithic. And the amount of energy harnessed per capita per year by each society was, as I have said, much the same. The Aztecs had evolved far beyond the Kuikuru because of the more effective way they were able to apply their immensely larger work force. The administrative structure of the state had grown so strong and effective that it could direct human labor to any state-determined end, from temple building to street sweeping. The Aztec triumph was, in short, not one of technology but of organization.

THE TECHNOLOGICAL DETERMINIST REPLIES

Having presented this much of our case, let us give the technological determinist a chance to reply. All right, he might say, I concede that many technological advances were not strictly necessary for the rise of the state or civilization. But others were necessary, or at least they accelerated the process. Consider, for example, the role played by weapons of war in the formation of the state.

The fact that 1 chiefdom among many competing chiefdoms succeeds in defeating and absorbing its enemies may very well be due to its superior arms. Indeed, the first unification of China by the Ch'in during the Chou period is attributed by the archaeologist Li Chi (1957:58) to the use of a newly developed halberd-like weapon called the *chi*. For Japan as well there is evidence (Sansom 1958:14-19) that the first major steps toward state formation were taken by those chiefdoms in contact with the Chinese mainland, who were thus able to obtain the iron weapons with which they defeated their enemies, armed only with inferior bronze ones.

To this argument I would reply as follows. Granted, weaponry had something to do with the rise of Oriental states. But it seems to me a near certainty that states would have arisen in China and Japan even without metal weapons. After all, they did in Mesoamerica. To be sure, they might have emerged centuries later, but they would have emerged just the same. Metal weapons were thus a *catalyst* for state formation rather than a *cause*: their role was merely to speed up a process that would have occurred anyway.

The technological determinist, in turn, might answer: All right, but the acceleration of a process is something real and important, and not to be minimized. Indeed, the determination of the precise time, place, and agency for the rise of the state, which in these 2 cases you admit is attributable to weapons of war, is a legitimate instance of technological determinism in political evolution. For, whatever the *ultimate* cause of state formation may be, here is evidence that military technology can at least be a *proximate* cause.

Admitting the appeal of this argument, the "organizational determinist" might nevertheless respond: True enough, technology did play a very significant role in these instances. Weaponry had a great deal to say about when, where, and by whom the first Oriental states were formed. But bear in mind that the invention of the weapons which permitted the societies possessing them to subdue their enemies was not simply a technical advance unrelated to societal requirements. In a very real sense, this development was *impelled* by the enormous pressure to survive and prevail constantly being exerted on warring chiefdoms. This pressure was in turn transmitted to smiths and armorers, who worked under forced draft, both literally and figuratively, to meet the need. The superior weaponry which certain few of them hit upon, and which helped to create the state, was thus not a free invention of autonomous craftsmen: it was a response to the propulsive force of organizational demands.

THE LESSON OF THE INDUSTRIAL REVOLUTION

Perhaps, the technological determinist might say, I cannot claim victory in this instance. But neither do I admit defeat. Instead, let me present a case in which technology was certainly no mere catalyst, but a genuine cause; where the event precipitated by technology would assuredly not have occurred without it, regardless of how many centuries had elapsed. I have in mind the Industrial Revolution. The critical step in the Industrial Revolution was the invention of the steam engine, which, for the first time in history, permitted the harnessing of nonhuman sources of energy on a vast scale. As everyone knows, an enormous cultural efflorescence followed the Industrial Revolution, and all of it can be traced straight back to that mechanical invention.

But this argument also has its answer: the Industrial Revolution, too, can be shown to have had its roots in certain organizational problems of society. Let us see how we can prove this.

The steam engine was no sudden technical innovation, but the culmination of a long series of mechanical inventions beginning in the Middle Ages. The small feudal states into which Europe was then divided suffered from a chronic shortage of labor, and the tools and machines developed during that time were largely designed to obtain the maximum productivity from this limited work force (Hoyle 1958:274).

That an inverse relationship exists between technological advance and the availability of labor can also be seen if we go back to the period of the Roman Empire. During Roman times economic conditions in Europe were, in many ways, the opposite of those which came to prevail during the Middle Ages. As the economic historian Tenney Frank (1933:386) has noted, while "labor-saving machinery was not entirely wanting [in Rome], . . . slave economy was so universal as to discourage inventiveness except in lines where human hands failed to meet needs." (See also Graves 1971:34-35.)

A striking example of how cheap and abundant labor inhibited technical advance can be found in Suetonius' *The twelve caesars* (1957:283). Once, during the reign of the Emperor Vespasian, "an engineer offered to haul some huge columns up to the Capitol at moderate expense by a simple mechanical contrivance, but Vespasian declined his services: 'I must always ensure,' he said, 'that the working classes earn enough money to buy themselves food.' "

This incident is enormously revealing. Indeed, it holds the key to the Industrial Revolution. As long as a large, labor-rich social system like the Roman Empire held together, relatively little

technological advance could be expected. Only after Rome fell and the labor force became fragmented and disorganized did economic conditions favor the mechanical experimentation that ultimately led to the steam engine and all the ramifying consequences of the Industrial Revolution.

The case of Rome also helps explain the failure of China to undergo an Industrial Revolution. For much of her history China was, like Rome, a monolithic state, with a large labor force at its command. Not surprisingly, many of the labor-saving inventions made in China remained, like the "mechanical contrivance" of Vespasian's engineer, unexploited by the society at large.

It is true that Joseph Needham, in his *Science and civilisation in China*, has disputed what he calls "the classical European stereotype of China as a civilisation with unlimited man-power incapable of inventing and adopting labour-saving devices" (1965:262). He also cites a number of mechanical devices, such as the water mill, water-driven bellows, and the wheelbarrow, which were invented in ancient China and which, he says, were widely adopted there (1965:28, 262). But Needham's argument is not entirely convincing. Evidence for the widespread use of these and other laborsaving devices is tenuous. Moreover, a number of the same contrivances, invented independently in Europe or diffused there from China, became much more widely used there than in China. And of course, the fact remains that China never gave rise to an Industrial Revolution.

The conclusion seems clear. As long as the rulers of China could readily mobilize a large work force, no such stimulus existed there to the invention and dissemination of machines as did in medieval Europe. China thus remained an essentially preindustrial nation until steam-driven machinery was introduced from the West.

We have countered the argument of the technological determinist, then, by showing that the series of mechanical inventions leading to the Industrial Revolution was not part of a self-directing process, but rather a response to socioeconomic conditions which favored the development of laborsaving machinery. Where these conditions did not exist, as in Rome and China, mechanical inventions were never fully utilized, and thus failed to transform society in any fundamental way.

CULTURAL MATERIALISM NOT REPUDIATED

At this point the reader might well ask if, by so qualifying the role of technological determinism, I am abandoning the philosophy of "cultural materialism" in which I was raised. The answer is, not at all. I regard my interpretation of the rise of the state and civilization as falling squarely within cultural materialism. After all, it assigns causal primacy to hard, external conditions of existence such as land shortage, population pressure, and warfare. At no point does it invoke subjective or ideological elements such as "cognitive maps," "psychic paradigms," or "mental templates."

Herbert Spencer (1899:543) once wrote: "it is not from conscious assertion of any theory, or in pursuance of any deliberate policy, that tribal and communal proprietorship of the areas occupied originate; but simply from the necessities of the case." The same can be said of civilization. Its development was not the effectuation of a conscious plan, but the unanticipated consequence of a series of necessary responses to prevailing circumstances. To quote Spencer (1899:395) again, "conditions and not intentions determine."

SUMMARY

Although technology sometimes plays a determining role in cultural evolution; with regard to the rise of civilization it does not seem to have played this role. Beyond the invention of agriculture and of stone cutting-tools, no particular technical advance was essential to the origin of civilization. Instead, civilization was the climax of a series of organizational solutions to problems posed by a limited food supply, population pressure, and warfare, to name the most important.

The imposing material aspects of the early civilizations, best exemplified by monumental architecture, were a concomitant of civilization, not a prerequisite. This interpretation, while stressing the responsiveness of technology to societal demands rather than its role as an independent driving force, in no way renounces cultural materialism, but merely elaborates and expands it.

Acknowledgments. An earlier version of this paper was read at the annual meeting of the American Anthropological Association in San Diego, California, in November, 1970. Some of the views concerning the relationship between certain conditions of labor and technological development which I expressed then, and which are here restated, were anticipated by Michael J. Harner. Dr. Harner discussed this relationship in a still unpublished paper entitled "Scarcity and Society," which he read at the Columbia University Seminar on Ecological Systems and Cultural Evolution on February 9, 1970. Although I heard this paper presented, I find it difficult to say which of its ideas were new to me, or how much it had influenced my thinking when I began writing the present paper some 8 months later. I know that the idea of why technical advance was more rapid in Feudal Europe than in Imperial Rome had occurred to me in 1965 or 1966, when I first read Suetonius' *The twelve caesars*. But leaving aside the vexing question of specific indebtedness, there is no doubt that regarding the relationship between population density, labor intensity, and technological development, Dr. Harner has been pursuing this subject longer, more actively, and more thoroughly than I. Finally, I would like to thank Janet M. Chernela for reading the present manuscript and offering several perceptive comments which led me to reorganize parts of it.

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