Machine Space

Ronald J. Horvath

Geographical Review, Vol. 64, No. 2. (Apr., 1974), pp. 167-188.

Stable URL:
http://links.jstor.org/sici?sici=0016-7428%28197404%2964%3A2%3C167%3AMS%3E2.0.CO%3B2-F

Geographical Review is currently published by American Geographical Society.

The Geographical Review

VOLUME LXIV April, 1974 NUMBER 2

MACHINE SPACE*

RONALD J. HORVATH

THE study of the ecumene, the permanently inhabited portion of the surface of the earth, is a venerable theme in geographical research. For hundreds of thousands of years humankind engaged in a seemingly ceaseless assault on the wilderness so that the ecumene might expand. The process has been depicted in terms of the gradual reduction of the wilderness and the expansion of the garden. It has generally been assumed that as the garden expanded, so did the ecumene. The growth of machine space stands in contradiction to this expansion, and in some respects we are replacing an organic wilderness "out there" with an inorganic one "within."[1] Now that the impact of humankind on the surface of the earth is appreciated in geographical thought, it is not premature to investigate the idea that the habitable area of the world itself may be in the process of being reduced quantitatively and qualitatively through the impact of modern technology.[2]

The purpose of this paper is to present a seldom-recognized aspect of the growth of modern technology — the concept of "machine space." Until now, technology has been viewed largely as an aspatial phenomenon, and one of the major tasks here will be to

* Portions of this paper were given at three meetings: the Association of American Geographers meeting in Boston, 1971; the Second Conference on Building Regions of the Future, Montreal, 1972; and the Twenty-second International Geographical Congress, Montreal, 1972.

[1] An analysis of these metaphors in American thought is found in Leo Marx: The Machine in the Garden (Oxford University Press, New York, 1964).

[2] William L. Thomas, Jr., edit.: Man's Role in Changing the Face of the Earth (The University of Chicago Press, Chicago, 1956).

➤ DR. HORVATH received his Ph.D. in geography from the University of California, Los Angeles, in 1966.

translate technology into explicitly spatial terms. If geographers are to participate more fully in planning and monitoring future technological growth, explicit recognition of the spatial dimension of technological change will be necessary. Machine space, or territory devoted primarily to the use of machines, shall be so designated when machines have priority over people in the use of territory. Automobile territory in modern American cities exemplifies the concept of machine space.

Automobile Territory

Automobile territory, or space devoted to the use of the automobile, is especially interesting because of the dominant position this one machine occupies in American culture. The automobile is so shrouded in myth and has so much symbolic meaning that we could call it our "sacred cow." In the minds of many Westerners, India's sacred cow has come to symbolize the lengths to which people will go to preserve a nonfunctional culture trait. But India's sacred cow is downright rational in comparison to ours. Could an Indian imagine devoting 70 percent of downtown Delhi to cow trails and pasturage, as we do for our automobiles in Detroit and Los Angeles? Every year we sacrifice more than 50,000 Americans to our sacred cow in traffic accident fatalities. In search of fodder to perpetuate the existence of our sacred cow, we support despotic governments in oil-rich lands. Perhaps the "sacred automobile" will replace the sacred cow as the metaphor that signifies the disorientation of priorities in promoting an artifact and maintaining an institution.[3] We are more than symbolically and ritually tied to our sacred cow — but so are the Indians to theirs.[4]

The automobile may prove to be the single most significant innovation in American culture during the twentieth century. Considered broadly, "automobility has had more important consequences for 20th century American man than even Frederick Jackson Turner's frontier had for our 19th century forebears."[5] This thesis is rather remarkable, for the automobile did not appear

[3] For an opposing interpretation see John B. Rae: The Road and the Car in American Life (The MIT Press, Cambridge, Mass., and London, 1971), especially pp. 335–358.

[4] Marvin Harris: The Cultural Ecology of India's Sacred Cattle, *Current Anthropology*, Vol. 7, 1966, pp. 51–66.

[5] James J. Flink: Three Stages of American Automobile Consciousness, *Amer. Quart.*, Vol. 24, 1972, pp. 451–473; reference on p. 473.

in any appreciable numbers until the turn of the century, after bicyclists paved the way for their wider use.[6] The number of automobiles registered in the United States climbed from fewer than 8,000 in the late nineteenth century to nearly 23 million by 1930. Assembly-line production, developed by Henry Ford, not only made this meteoric growth possible but also influenced industrial production methods around the world. Since the depression and World War II, automobile registration has leapt to approximately 100 million. Forty-five percent of the motor vehicles registered in the world are in the United States.[7] We shall examine the spatial consequences of the growth of the automobile in two localities, in order to make explicit the spatial dimensions of the automobile as a machine.

Automobile territory includes any area that is devoted to the movement, storage, or servicing of automobiles. The criterion used to classify individual parcels into "machine space" (in this paper, automobile territory) rather than "people space" is: Who or what is given priority of use in the event of a conflict? Areas of conflicting use are classified as machine space when the machine is normally given the right-of-way. Therefore, streets, alleys, parking spaces, driveways, garages, gasoline stations, car washes, automobile supply stores, and so on are all shown as undifferentiated machine space in Figures 1 and 2. These maps depict the distribution of automobile territory in parts of East Lansing and Detroit, Michigan.

The automobile territory in East Lansing can be divided into three subareas, based on the overall percentage of the area of each block that is assigned to automobile territory, on the shape of this territory, and on the types of land uses associated with the subareas in each block. The first subarea is the retail business district, which roughly runs along Grand River Avenue and of which approximately 65 percent is devoted to the automobile. A large amount of this subarea is devoted to parking lots and to automobile servicing. The second subarea is a high-density residential area that consists primarily of rented dwellings occupied largely by university students. This area is roughly located north of the retail district and west of Division Street. About 50 percent of this

[6] Sidney H. Aronson: The Sociology of the Bicycle, *Social Forces,* Vol. 30, 1952, pp. 305–312. James J. Flink (America Adopts the Automobile, 1895–1910 [The MIT Press, Cambridge, Mass., 1970]) discusses the early years of the automobile.

[7] *United Nations Statistical Yearbook, 1972,* New York, 1973, pp. 419–421.

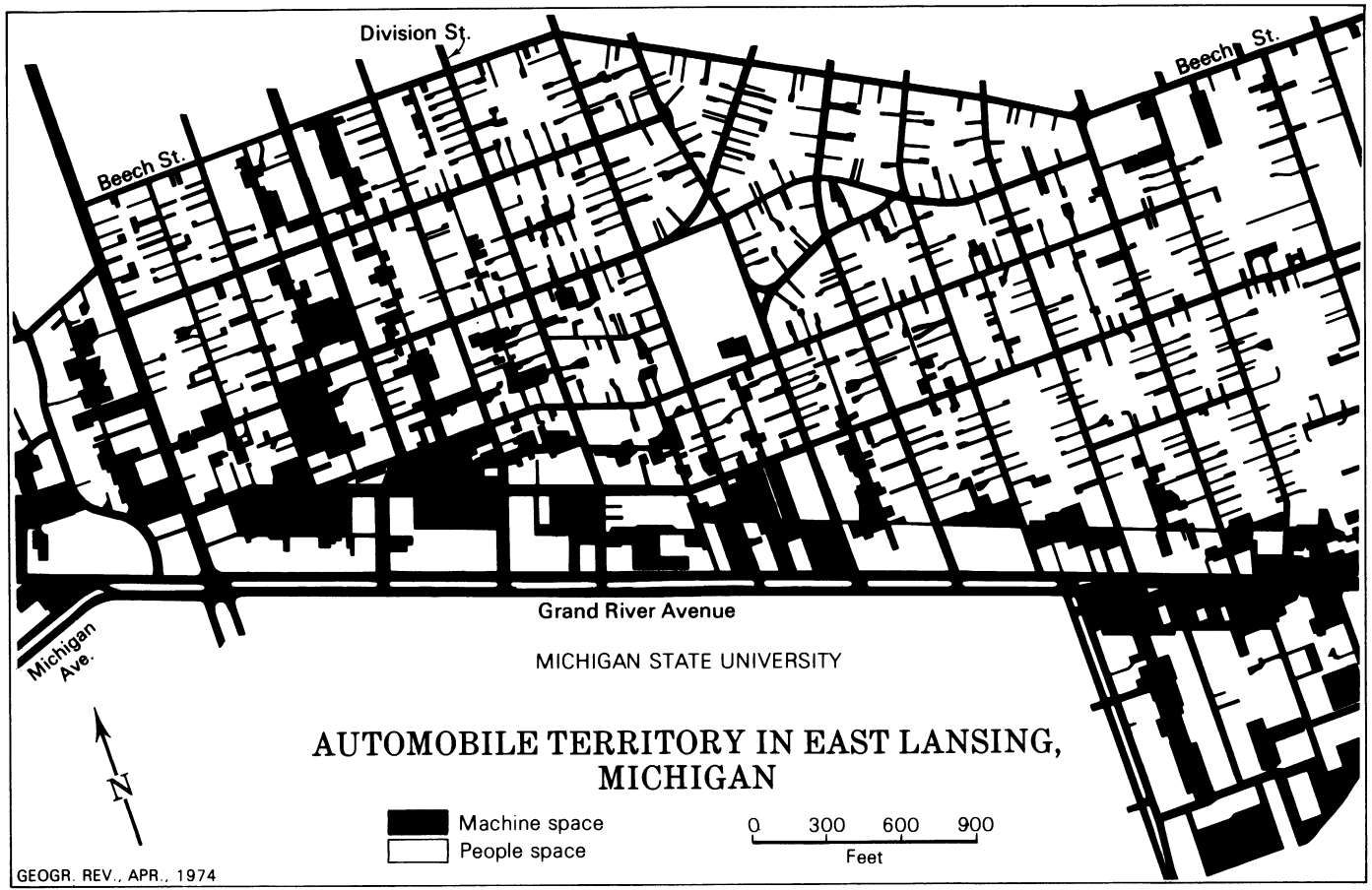

FIG. 1 – Machine space (automobile territory) in a part of East Lansing, Michigan, spring, 1970, at ground level only. Prepared from field maps with the assistance of Michael Graff, Paul Lamb, John Clark, and Malcolm Haynes.

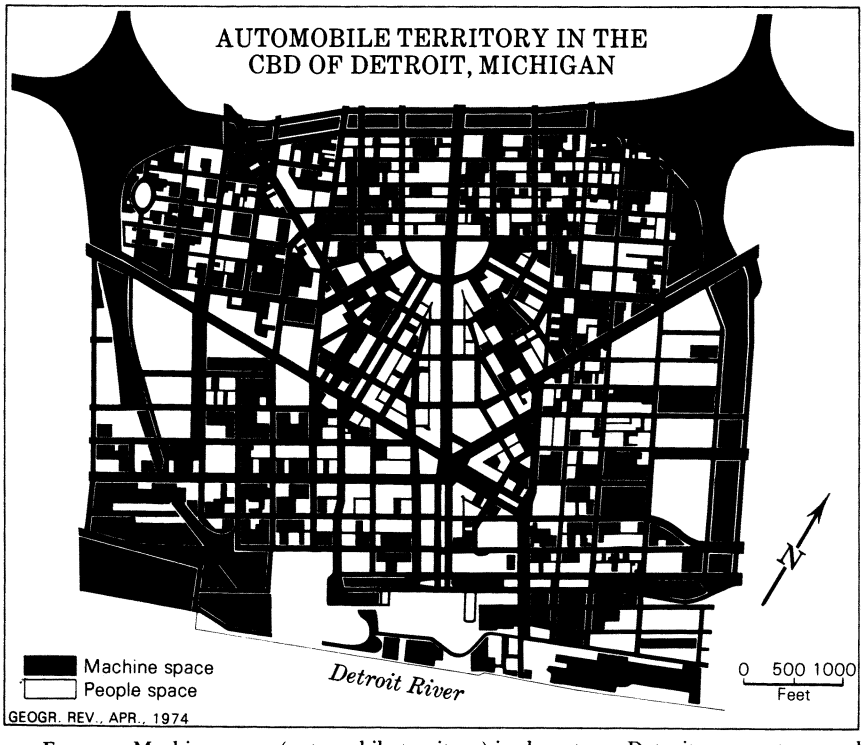

FIG. 2 — Machine space (automobile territory) in downtown Detroit, 1971, at ground level. Prepared from field maps, and with the assistance of T. J. Walters, city planner for the city of Detroit.

subarea is devoted to the automobile. Parking lots associated with new apartment buildings add noticeably to the gradual encroachment of automobile-storage space on people space. The third subarea, located east of Division Street and north of the business district, is a low-density area of owner-occupied, middle-class homes. An average of 25 percent of this area is devoted to the automobile; driveways and garages form the only nonstreet type of auto use.

The map of automobile territory in the Central Business District of Detroit (Fig. 2) illustrates the influence of city size on the distribution of automobile territory. The area defined as the CBD by the Detroit planning department includes part of what is known in the ecological literature as the zone in transition. The overall pattern and the percentage of land designated as automobile territory resemble those found in the retail district of East Lansing, but the district is more extensive and the percentage is higher.

Machine space such as automobile territory can be divided into categories. Figure 3 shows a segment of East Lansing, just to the west of but partly depicted in Figure 1, that has been divided into movement, storage, and service categories of automobile territory. These and other distinctions must be refined so that the subdivi-

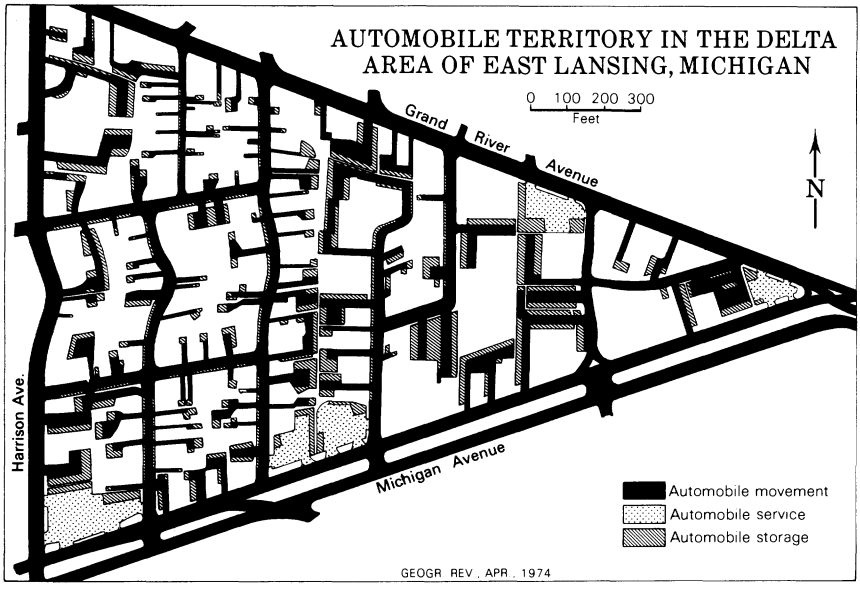

FIG. 3 — Types of automobile territory in the Delta Area of East Lansing, Michigan, spring, 1972, at ground level. Prepared from field maps.

sions of automobile territory which contribute to its areal growth can be determined.

The process by which automobile territory expands is described metaphorically by Jane Jacobs as "the erosion of cities."[8] As it ages, a city block or a neighborhood exhibits some parallels to the erosion of landforms, as seen in the shape of machine-space expansion. We may compare the erosion of a mesa or plateau to the spread of automobile territory in a city block (Fig. 4). The areas that are youngest in terms of the average age of subdivision exhibit youthful features. The initial stage of erosion by driveways and garages, a pattern characteristic of the low-density area of owner-occupied, middle-class homes, is shown. The expansion of

[8] Jane Jacobs: The Death and Life of Great American Cities (Random House, New York, 1961), pp. 338–371; reference on p. 370.

automobile territory over time is not unlike "headward erosion," and one finds an integrated pattern of this territory emerging in early maturity. A block from the high-density, student residential area, representing this stage, is shown in the diagram. The oldest part of the city has the largest percentage of automobile territory, which are labeled here late maturity and old age. These patterns are found in or on the edge of business districts, where people spaces stand out like monadnocks on a peneplain of automobile territory.

The pattern of expansion of automobile territory is a result of standard planning practices in the United States. Inordinately large amounts of the resources of local governments are spent on the task of keeping cars moving. Indeed, one planner observed that, "in retrospect, I apparently put in more time for General Motors as a city planner than for the municipality that paid me."[9] Planners and transportation engineers carefully attempt to anticipate each potential point of traffic congestion and then lavishly (in territorial terms) relieve existing or anticipated congestion by expanding automobile territory. And as each bottleneck is relieved, a new bottleneck appears elsewhere in the system because the number of cars appears to expand, in parkinsonian fashion, to fill the space available. Stream erosion likewise focuses energy at the constrictions along its course.

One might think that a point would be reached when the expansion of automobile territory could occur only at the expense of losing people. Victor Gruen discovered that "for each additional automobile penetrating the heart of a city, one visitor or inhabitant of the same heart area is lost."[10] Vertical expansion only delays this recognition. It might seem obvious to stop planning for machines when that point is reached, but it always comes down to who the people are that are being removed and whose machine is being planned for. Kenneth Schneider's "iron law" of city planning merely explains an urban regularity: "the scale and form of the city expand to serve the city's predominant citizens."[11] Viewing the city as property rather than as people is a fundamental factor in such planning practices.

---

[9] Kenneth R. Schneider: Autokind vs. Mankind (W. W. Norton and Company, Inc., New York, 1971), p. 15. Lewis Mumford has long been a critic of planning practices that relate to the automobile. See especially Lewis Mumford: The Highway and the City (Harcourt, Brace & World, Inc., New York, 1953).

[10] Quoted in Schneider, *op. cit.* [see footnote 9 above], p. 147.

[11] *Ibid.*, p. 60.

The Growth of Machinekind

The meaning of modern technology offered here is derived from a theoretical framework that focuses on growth-based sociocultural change.[12] Crisis, in this framework, refers to that phase of change when the limits to further growth progressively impinge on a given system. If we represent the growth of a system by an S-shaped curve, by far the most common empirical growth curve, then crisis would refer to the entire second half of the curve, when growth continues at a decreasing rate.[13] Crisis, that is, growth during conditions of increasing saturation, is symptomized by the appearance of contradictions in the relationship between the system in crisis and the larger system of which it is a part. The way the contradictions are dealt with and the manner in which the limits are reached determine the outcome of the crisis.

The significance of the impact of saturation conditions on the growth of technology is that contradictions in the relationship between machines and people emerge progressively as our economy pushes our culture toward the earth's limits. The source of these contradictions can be understood in terms of a transformation of the relationship between people and machines. Several factors cause the transformation. People and machines have many of the same needs, including air, territory, water, and energy. These items are used in a mutually exclusive manner, and the general tendency is for exclusiveness of use to increase as a function of growth against limits. Therefore, an inherent conflict between people and machines exists, and it becomes manifest through the process of growth.

Applying these transformational rules to the space requirements of technology, we begin by recognizing that both people and machines require space. Although machine space — a street, for example — may be occupied by machines only occasionally, that space is clearly allocated for full-time use by machines. Furthermore, since some space can be used either by a machine or by people at a given time (which is also true for some of the other requirements of machines and people), it is necessary to have rules that govern access and use. With the increased number of

[12] An early version of the theory was presented in R. J. Horvath and C. Akatiff: On the Meaning of the S-Shaped Curve (an unpublished paper presented at the meeting of the Association of American Geographers, San Francisco, 1970).

[13] For a closely parallel conceptualization of crisis, see Derek J. De Solla Price: Little Science, Big Science (Columbia University Press, New York, 1963), pp. 1–32.

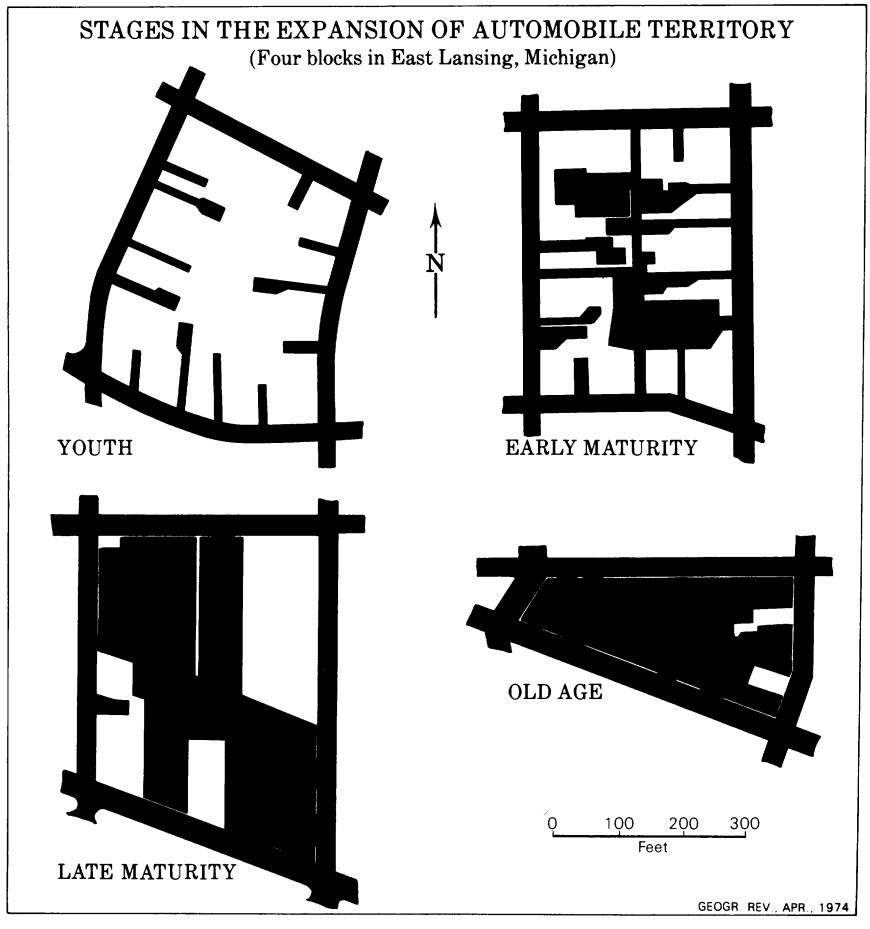

FIG. 4

automobiles, it has become common to make automobile territory even more exclusive.

Historically, the promotion of machinekind was justified because machines had an increasing utility for humankind. During the past century and a half of exponential technological growth, many of the resources needed by machines have been viewed as infinite. Air, for example, has been free — that is, not a part of the cost side of an economist's ledger because of its abundance. Nothing, not even air, is free in this sense any more on "spaceship earth." Yet man continues to lavish on machines the resources needed by people. The contradictions arise when the increased utility of technological development does not compensate for the

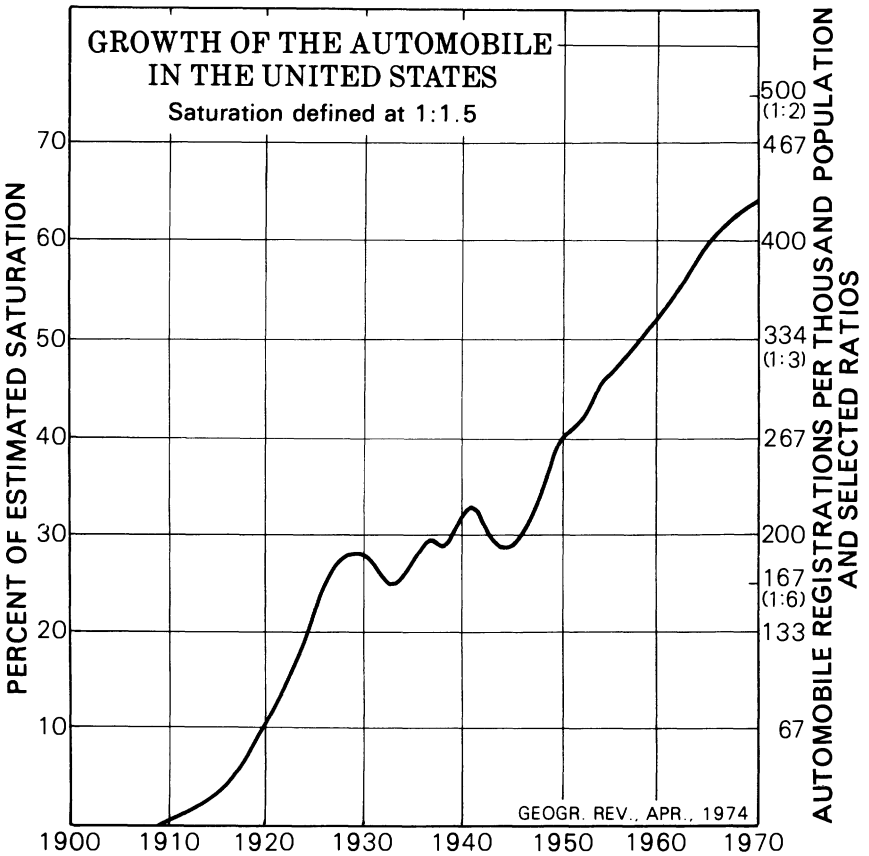

FIG. 5 — Growth of the automobile in the United States. Sources: *Historical Statistics of the United States, Colonial Times to 1957*, U.S. Bureau of the Census, Washington, D.C., 1960, pp. 7 and 462; and *Statistical Abstract of the United States, 1958–1973*, 79th–94th edits.; U.S. Bureau of the Census, Washington, D.C., 1958–1973.

loss of requirements needed by people. Eventually the point is reached when man must decide whether machines or people are to have exclusive access to a given resource. Should the Rhine River and Lake Erie be industrial sewers or sources of potable water? Should the air around Los Angeles be a "sewer in the sky" or a source of nonpathogenic air for people? Should our central cities be homes for people or for machines? These contradictions, owing to the conflicting and therefore competitive use of finite requirements, may lead to changes in attitude when they are perceived as such. Intergroup conflicts arise when a shift in values is met with resistance by those who perceive their interests as tied to continued technological growth. I would suggest that the growth of

the antitechnology movement in many industrial countries is a manifestation of this shift.[14]

The Growth of the Automobile

In the United States the automobile, having risen to an unprecedented position of dominance in the history of technology, quite clearly exhibits the advanced tendencies in the posited relationship between people and machines in crisis. The position of the automobile varies substantially, with places like Los Angeles exhibiting these relational tendencies most clearly. Let us consider the ways in which the foregoing framework could be used to analyze the automobile in the United States. With the circulation of roughly 100 million cars in the American landscape, problems have appeared: atmospheric pollution, traffic accidents and congestion, energy shortages, and the expansion of automobile territory. Some of the more optimistic projections place the number of automobiles in the United States at 300 million by the end of this century.

I contend that the automobile is in a growth-based crisis in terms of the foregoing framework. The set of propositions about the transformation of technology through growth explains, by its very success, some of the puzzling developments, especially in the last ten or fifteen years, in the United States as well as in other countries where the number of automobiles has soared. During this period, substantial public opposition to the automobile has emerged. For example, a car was buried at San José State College on Earth Day, 1970; a mayor who opposed highway construction was elected in Portland, Oregon; the national Clean Air Act was passed; and con-

[14] Key sources on this topic include: Jacques Ellul: The Technological Society (Vintage Books, New York, 1964); Lewis Mumford: Technics and Civilization (Harcourt, Brace & Company, Inc., New York, 1934); *idem,* The Myth of the Machine (Vol. 1, Harcourt, Brace & World, Inc., New York, 1966; and Vol. 2, Harcourt, Brace Jovanovich, Inc., New York, 1970); Eugene S. Schwartz: Overskill: The Decline of Technology in Modern Civilization (Ballantine Books, Inc., New York, 1971); Theodore Roszak: The Making of a Counter Culture (Anchor Books, Garden City, N.Y., 1969); Ezra J. Mishan: The Costs of Economic Growth (Praeger Publishers, New York, 1967); and William Bunge: Fitzgerald: Geography of a Revolution (Schenkman Publishing Co., Inc., Cambridge, Mass., and London, 1974), pp. 240–244. The idea that there is no technological solution to many of the problems that we currently face is suggested more and more frequently. See "Blueprint for Survival," *Ecologist,* Vol. 2, 1972; Barry Commoner: The Closing Circle (Alfred A. Knopf, Inc., New York, 1971), pp. 140–177; Garrett Hardin: The Tragedy of the Commons, *Science,* Vol. 162, 1968, pp. 1243–1248; and Donella H. Meadows and others: The Limits to Growth (Potomac Associates, Washington, D.C., 1972), pp. 129–155.

troversy erupted over automobile safety. In hundreds of communities, public sentiment against the building of roads was aroused.[15] The magnitude of this shift in attitude toward the automobile has led some people to claim that we are entering the end of "the age of the automobile."[16]

The difficulty in comparing shifts in attitude, such as those vis-à-vis the automobile, with the growth of the automobile itself, is the determination of the limits to further growth. What is offered here is a first attempt to estimate the limits. The approach assumes that the limits to automobile growth will be reached before there is one automobile for each person. Currently, the ratio is one auto for every 2.3 persons in the United States. It is estimated that the limits to further growth will occur at one car for every 1.5 persons, since large numbers of people either are unable to drive (because they are too young or too old, for example) or are unwilling to drive. It is assumed that the "two-car family" will still not move the estimated national ratio above 1:1.5, or 670 automobiles per 1,000 people.

As shown by the data in Figure 5, the United States is approximately two-thirds "full." According to the definition of crisis offered earlier — when attitudes begin to shift — the end of the 1950's was the beginning of a crisis of growth. Since then the automobile has gone from being the object of criticism by a few individuals, like Lewis Mumford and Jane Jacobs, to a mass-based, many-faceted public issue.[17]

Machine Space as Alienated Territory

Interest in the concept of alienation may well parallel increased concern for a more "humane" human geography. Although the concept of alienation is well known in the social sciences and the humanities, it is little used in geography. The notion of territorial alienation is offered at this point as one of a series of analytical

[15] Some discussion of the automobile-protest phenomenon has appeared in the geographical literature. See, for example, Julian Wolpert, Anthony Mumphrey, and John Seley: Metropolitan Neighborhoods: Participation and Conflict Over Change, *Comm. on College Geogr. Resource Paper No. 16,* Assn. of Amer. Geogr., Washington, D.C., 1972; and Bunge, *op. cit.* [see footnote 14 above].

[16] The period we are in has been referred to as "Automobile Consciousness III" because the era of uncritical mass accommodation to cars has ended and because "automobility is no longer an historically progressive force for change in American civilization" (Flink, Three Stages [see footnote 5 above], p. 472; see also pp. 468–469).

[17] Emma Rothschild (Paradise Lost: The Decline of the Auto-Industrial Age [Random House, New York, 1973]) provides a comprehensive view of the problems facing the automobile industry in the United States.

concepts needed for a humanly oriented geography, in which the content of places is described and explained in human rather than in property terms.

The term "alienation" has at least two geographical or territorial aspects. The first is seen in the term "alien," which refers to a person from another place; the second, in the legal sense of the term, which is used to describe a change of property (or territory) from one owner to another. The most common use of the term focuses on the existence of some kind of estrangement or separation. The type of separation involved varies from scholar to scholar. For example, Hegel was concerned with an individual's alienation from the social stratum, whereas Marx focused on labor's separation from control of the productive process.[18] Territorial alienation, as it is referred to here, denotes the separation or estrangement between people and the spaces that they depend on for their livelihood or well-being. Although the nature of this separation is many faceted, the discussion of alienation in relation to machine space focuses on rights of use and on the institutional apparatus that controls them. Given the type of evidence that is available and the canons of documentation to which academia so widely subscribes, the idea that machine space is alienated territory is set forth as an exploratory hypothesis.

What or who has priority of use of machine space — machines or people? Machines, quite obviously, by definition. Consider a hypothetical situation of a group of children who are playing baseball in an empty municipal parking lot. If someone decides to park his car in the middle of the lot, the children must discontinue their game. The individual could be a stranger, indeed, not even a local taxpayer (whereas the children are the sons and daughters of the taxpayers who financed the parking lot), but his right to use the lot supersedes the rights of the children because he came in a machine. The exclusive use of space devoted to machines varies substantially. Pedestrians are strictly forbidden on interstate highways, whereas one's own driveway may be occupied by an

[18] Richard Schacht (Alienation [Anchor Books, Garden City, N.Y., 1971]) reviews the various uses of the concept of alienation. The term "alienation" has characteristically been used when some preexistent or desired unity is first assumed. A state of alienation then refers to a condition in which an individual or a group becomes estranged or separated from that unity, as in Hegel's notion of the individual's loss of unity with one's social substance. The social substance becomes "other" to the individual. Marx's concept of alienated labor is similar, in that labor becomes "other" to the worker because the working class has no real control over the product of its labor. See Bertell Ollman: Alienation: Marx's Conception of Man in Capitalist Society (Cambridge University Press, Cambridge, Mass., 1971).

automobile only occasionally. The trend, I would suggest, is toward increasing exclusiveness of use of machine space by machines. And city centers, as the focal points of an industrial civilization, have become the homes of machines, not of people.

The rights of use are supported by the major political and economic institutions of American society. Machine space as property has the dubious status in the American land-tenure system of always seeming to belong to another. Consider a modern fable. Two children are killed by automobiles on some suburban road within one year. All of the people who live on the street decide to do something about it. The outcome of their efforts depends on who the people are, since some have less status, wealth, and power than others. Let us say that the neighbors are middle-class whites and that they decide to express their grievances by going through the proper channels. The effects of closing off this street to through traffic are studied, and the conclusion is that through traffic is so infrequent that closing the street off would not place a burden on the highway system. In fact, after they become involved in the matter, the people themselves decide to limit access for their own cars in some way. It occurs to them that they rather enjoy meeting one another and that it would be nice to get together more often. Then some of the neighbors think of alternative uses for the street: a tennis court, a place to flood with water during the winter for ice skating, and so on.

Meanwhile the proposal, backed unanimously by the neighborhood, meets stiff resistance at city hall. "The closing of a road is beyond our power," says the elected official. "Since certain state moneys were involved, the governor and the state legislature must pass a special bill authorizing the closure." Undaunted, the Citizens Committee to Close Down the 400 Block of B Street presents the case to their state representatives in the capitol. After several months of study an answer comes back: "The matter is out of our hands. Your street has been defined as an alternate route for the movement of long-range ballistic missiles for national defense; the president and Congress will have to approve its closure." Frustrated, the people of the neighborhood return home dutifully, to once again become members of McLuhan's world village by relating to one another passively through the magic medium of television.[19] A modern fable ends with the triumph of technology over incipient community formation.

[19] Marshall McLuhan: Understanding Media (McGraw-Hill Book Co., Inc., New York, 1964).

Machine space, then, is alienated territory. But machine space is only one of many symptoms of our growing estrangement from nature as well as from one another. If every human relationship (including that with one's own self) is separated by one or more machines, and if the space required for these machines occupies greater amounts of territory (separating us even more from one another), then machinekind plays a crucial role in the progressive alienation of mankind. More specifically, people are not in control of vast amounts of territory. The objective nature of this separation leads me to label machine space as alienated territory. The political and economic institutions that place limitations on people's ability to control machine space are sufficiently important to cause geographers to examine the process of territorial alienation in places like the United States. Machine space, however, has a second attribute that compounds the contradiction that the examination of alienation brings into focus: it is a place of death.[20]

The automobile was the fifth leading cause of death in the United States in 1968, after diseases of the heart, cancer, strokes, and pneumonia, according to the National Center for Health Statistics.[21] Motor-vehicle accidents are the chief cause of death among Americans under the age of thirty-five. As the number of automobiles has increased, so have highway fatalities. The relationship between the number of registered automobiles and automobile-related fatalities since 1913 can be expressed as a correlation coefficient of .93. In order to get some sense of the magnitudes involved, it could be pointed out that more Americans have been killed in automobile accidents since 1900 than in all of the wars that the United States has engaged in since 1775 (approximately 1,957,000 automobile fatalities and 1,154,000 war fatalities).[22] Yet when Ralph Nader suggested that certain cars were "unsafe at any speed"[23] he was treated in a scandalous manner by General Motors.[24]

The automobile-accident syndrome, that is, a set of symptoms that regularly occur together and whose pathogenesis has not been

[20] See William Bunge: Detroit Humanly Viewed: The Cities of Death, Need, and Superfluity, *in* Futurescapes: The When and Where of Tomorrow (edited by Ronald Abler and others; Duxbury Press, North Scituate, Mass., in press), Chap. 12.

[21] "Accident Facts" (National Safety Council, Chicago, 1972), p. 9.

[22] *Ibid.*, p. 49.

[23] Ralph Nader (Unsafe at Any Speed [Grossman Publications, New York, 1965]) has stressed the automobile element in the automobile syndrome.

[24] Robert F. Buckhorn: Nader: The People's Lawyer (Prentice-Hall, Inc., Englewood Cliffs, N.J., 1972), pp. 1–34.

sufficiently established, can be analyzed either at the intersystem level or, more commonly, at the intrasystem level. Intrasystem analysis defines the automobile transportation system as having four components: drivers, automobiles, automobile territory, and pedestrians. The objective of this mode of analysis is to determine to what degree each of the components of the system is responsible for the "accident experience." At different times each of the components has been the object of publicity campaigns and of research activities.

For decades highway safety experts have conducted programs directed at reforming, educating, propagandizing, or in other ways harassing drivers. Some experts have begun to admit, however, that singling out the driver has little or no hope of further reducing accidents.[25] Focus on the automobile has thus far led to minor modifications, including seat belts, safety glass, and a bumper capable of absorbing the impact of a collision at two and a half miles per hour. The third component, automobile territory, has been the subject of much recent research in the area of highway design. It was hoped that the interstate highway system would reduce the accident rate.[26]

Despite efforts to make the automobile a safer machine, the number of fatalities has continued to climb (Fig. 6). In 1972, 56,300 people were killed, approximately the number of Americans killed in Vietnam. Safety experts prefer to emphasize the mileage death rate (fatalities per 100 million miles driven) rather than the number of fatalities or population death rate. Until the late 1950's, the mileage death rate declined steadily; since the early 1960's it has hovered at approximately five deaths per 100 million miles driven. One factor not taken into account by the milage-death-rate measure is that people, because of the spatial impact of the automobile, are now required to travel greater distances in order to engage in the same activities as in early times.[27] Consequently, the population death rate is an important measure of the human cost of the rise of the automobile.

---

[25] David Soloman: Needed: An Unbalanced Highway Safety Program (an unpublished paper presented at the Symposium on Highway Safety, University of North Carolina, Chapel Hill, Apr., 1970), pp. 3–6; and Arthur D. Little: The State of the Art of Traffic Safety (Praeger Publishers, New York, 1970), p. 31. Many people, however, continue to maintain that the driver is the principal cause of accidents (Rae, *op. cit.* [see footnote 3 above], p. 349.

[26] See, for example, J. A. Fee and others: Interstate System Accident Research Study No. 1 (U.S. Dept. of Transportation, Washington, D.C., 1970).

[27] E. S. Schwartz (*op. cit.* [see footnote 14 above], p. 71) credits Bertrand Russell with pointing out that "each improvement in locomotion has increased the area over which people are compelled to move."

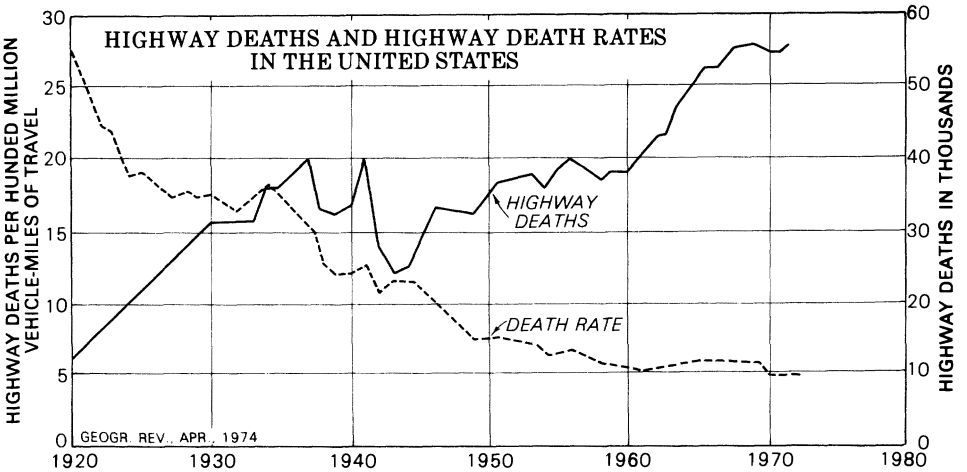

FIG. 6 — Highway deaths and highway death rates in the United States. *Source:* Accident Facts [see text footnote 21], p. 40.

TABLE I—PASSENGER DEATH RATES

TYPE OF TRANSPORTATION	AVERAGE DEATH RATE PER 100 MILLION PASSENGER MILES, 1969–1971
Passenger automobiles and taxis	2.10
Passenger automobiles on turnpikes	1.08
Buses	0.19
Intercity buses	0.05
Railroad passenger trains	0.12
Scheduled air transport planes (domestic)	0.10

Source: Accident Facts [see text footnote 21], p. 75.

When we examine the automobile at an intersystem level, we find it to be at least ten times as dangerous as buses, trains, and airplanes, in terms of the mileage death rate (Table I). It is my contention that more attention should be directed at comparing different modes of transportation from the point of view of the issues raised by the automobile, such as the requirements of both people and machines, because at this intersystem level the magnitudes involved are so great that none of the ambiguities involved in the intrasystem analysis remain and the deadliness of the automobile is brought into sharp focus.[28]

Automobile territory is death space in another way, one that may ultimately be more serious than the casualties from traffic

[28] In a highly praised study of motor-vehicle safety, it was pointed out that "the concept of 'cause' has little operational significance in the study of accidents. Traffic accidents are most meaningfully viewed as failure of the system rather than failure of any single component" (Little, *op. cit.* [see footnote 25 above], p. 31).

accidents: it is ecologically dying or dead. Ecological death need not mean complete absence of life, but rather may refer to a concept akin to the devolution of a life system, from complex to simple, from many species to few. Paving a part of the surface of the earth has significant ecological consequences: percolation of groundwater is retarded, the potential damage from floods increases, soils are degraded, flora and fauna are reduced or removed, and so on. The expansion of automobile territory has already been associated with increased air pollution. Barry Commoner, who has provided us with an analysis of this problem, shows how a series of "technological solutions" to the problem of air pollution has merely led to the transformation of pollution into increasingly more dangerous types of air pollution, such as the reduction of hydrocarbons and carbon monoxide, with a consequent increase in nitrogen dioxide.[29] It is interesting to recall that part of the early enthusiasm for the automobile was the prospect of eliminating "street dust," which consisted mainly of horse dung, and other health hazards associated with the great concentrations of horses in American cities.[30]

Strip-mining territory, perhaps more dramatically than automobile territory, illustrates the idea of machine space as ecological death space. Already 1 percent of the United States has been strip-mined and at least another 1 percent is estimated to have economically strippable reserves.[31]

Spatial Antidotes

A discussion like the foregoing almost inevitably raises the question, "So, you have pointed out the problems, but what are the solutions?" The reaction is a valid one, and a brief attempt will now be made to answer this question. However, three limitations should be established at the outset. First, since this analysis of technology has been primarily spatial, the proposed solution is also spatial. I do not claim that the problems of technology in general or of the automobile in particular are only spatial, but the territorial demands of machines must be considered and certain uniquely spatial solutions to problems of a technological origin should be considered.

Second, the framework for implementing these solutions has

[29] Commoner, *op. cit.* [see footnote 14 above], pp. 66–80.

[30] Flink, Three Stages [see footnote 5 above], p. 456.

[31] J. Stacks: Stripping (Sierra Club, San Francisco, 1972), p. 26.

been called advocacy geography, human exploration, the problem-solver method, and the like.[32] People who use this framework usually feel that a problem should be identified at the community level, ideally by its members. Experts may then be called in to help solve a locally defined problem. This does not mean that the concept of machine space cannot be viewed at another scale, such as at the state or national level, but that the problems of technology have only begun to be recognized. Furthermore, it may be premature to speak of formulating state or national policy on the quantitative and qualitative aspects of machine space, although changes at this level can occur rapidly, as evidenced by the response to energy shortages in 1973 and 1974. Third, mounting evidence suggests that more emphasis should be placed on seeking nontechnological solutions to problems of a technological origin. Accordingly, the proposals offered here are social rather than technological antidotes.

The first antidote offered is to attempt to limit or contain the growth of machine space. A powerful way for geographers to begin is simply to make a map of the distribution of machine space in a locality. Better yet, they should participate with other members of the community in the making of a map because then it becomes the community's map.

This kind of map initiates the process of diagnosis that Ellul and Zelinsky speak of by identifying the amount of automobile territory that already exists[33] and serves as an impetus for gaining consensus in the community about how much automobile territory is sufficient. My experience suggests that as soon as people realize how much of their community is devoted to one type of machine and are shown how much more machine space exists in other communities, the value of setting limits to the areal growth of

[32] For an example of the usage of the term "human exploration" see W. Bunge: The First Years of the Detroit Geographical Expedition, *Field Notes, Discussion Paper No. 1*, 1969, pp. 1–59. Advocacy planning and geography is discussed in Kenneth E. Corey: Advocacy in Planning: A Reflective Analysis, *Antipode*, Vol. 4, No. 2, 1972, pp. 46–63; Myrna Breitbart: Advocacy in Planning and Geography, *ibid.*, pp. 64–68; and Russ Roach and Bill Rosas: Advocacy Geography, *ibid.*, pp. 69–76. Ronald G. Havelock and others (Planning for Innovation through Dissemination and Utilization of Knowledge [Univ. of Michigan Inst. for Social Research, Ann Arbor, 1971], Chap. 10) call this approach the problem-solver method.

[33] Jacques Ellul: The Technological Order, *in* The Technological Order (edited by Carl F. Stover; Wayne State University Press, Detroit, 1963), pp. 25–26; and Wilbur Zelinsky: Beyond the Exponentials: The Role of Geography in the Great Transition, *Econ. Geogr.*, Vol. 47, 1970, pp. 498–535: reference on pp. 519–521.

machines is appreciated. Indeed, calling a moratorium on the expansion of machine space can be a rational decision if the people determine that their community's machine space has already reached its limits to growth. Moreover, the positive aspect of this antidote is that human energy and resources currently devoted to the growth of machine space can be channeled into more productive activities. At the least, these maps initiate the process of monitoring machine space.

A second spatial antidote is the creation of automobile-free zones in a community. These can be set up in a variety of locations, can be of different sizes, and can exist for different periods of time. For example, a street or a parking lot can become people space when demand for automobile space is less.

Experiments with automobile-free zones have already been initiated in more than a hundred cities, especially in western Europe and to a lesser extent in North America.[34] The motivation for creating vehicle-free downtown areas varies. Some cities want to create a more attractive shopping environment; others, to reduce air pollution; and others, to preserve the historic character of the core. Relieving traffic congestion appears to be a widespread concern.

Although a master plan for an automobile-free area can be extensive, like Vienna's plan, which proposes a vehicle-free area three-quarters of a mile in diameter, implementation will necessarily be gradual. Time is needed for developing new means of transportation to replace the automobile.

The purpose of the concept of automobile-free zones is to devise a means by which people can acquire the experience needed to lessen their dependence on technology as the solution to human problems. Hence, more experiments with vehicle-free zones, in urban as well as rural locations, temporary as well as permanent, and both in large and in small areas, should give us more insight into the consequences of limiting automobile territory.

The remedy, rather than the antidote, to the problems associated with the automobile lies in creating alternative means of transportation. The criterion we must use in selecting these alternatives is that they must make smaller demands on the air, water, territory, energy resources, and so forth than the automobile does. Considering energy demands alone, we see that

[34] "Vehicle-Free Zones in City Centers: The European Experience," *HUD International Brief*, Vol. 16, 1972.

transportation places enormous demands on the finite and dwindling energy resources of our planet and is, simultaneously, a major polluter. In fact, transportation of people and goods constituted about 25 percent of the total energy consumed in the United States in 1970.[35] As natural resources become scarce or inaccessible and as their costs rise, our ability to deal with pollution technologically will be diminished. Eric Hirst has offered calculations on the energy efficiency of existing means of transportation, using the single-passenger automobile as the standard of comparison. He reported that bicycles are twenty-two times as energy-efficient as cars; walking, fifteen times; buses, almost four times; and railroads, two and one-half times. Only airplanes are less energy-efficient than cars.[36] We need similar data for the relative spatial efficiency of transportation alternatives.

Nevertheless, the automobile is a fact of American life. What nontechnological means can be found to make it a more efficient means of transportation? In the short run, we must find ways to get more people into fewer cars. Although many such experiments are being tried, I would propose going to the heart of the matter: the relationship between status and technological privilege must be changed. If you are a high government official in Washington, D.C., a subsidized parking place commonly comes with your position. A professor driving alone to almost any university can obtain a parking place, whereas a car full of students cannot. A nontechnological solution would be to distribute parking places on ecological criteria rather than on those of social status. For example, six custodians coming to work in a small car would get a choice parking place; a company or university president driving to work alone would receive the least desirable parking place. The exponential growth of the assaults on our finite and fragile ecosystem make this kind of reversal imperative.

That the growth of technology in general and of the automobile in particular has been overwhelmingly beneficial to humankind is self-evident. However, the period of unquestioned accommodation to technological growth is over. The concept of machine space

---

[35] Eric Hirst and John C. Moyers: Efficiency of Energy Use in the United States, *Science,* Vol. 179, 1973, pp. 1299–1304; reference on p. 1299.

[36] Eric Hirst: In Praise of Bikers, Hikers, and Crowded Cars, *Natural History,* Vol. 81, No. 7, 1972, pp. 15–16. These calculations of energy demands and the analysis of highway fatalities above point to the need for more intersystem analyses of solutions to the transportation problem. See also S. S. Wilson: Bicycle Technology, *Scientific American,* Vol. 228, No. 3, 1973, pp. 81–91.

is offered as one way for geographers to participate in the wider questioning of the human purpose and of the consequences of further technological growth. Analyses of other types of machine space, as well as larger-scale and comparative studies of automobile territory, need to be undertaken. But research should be accompanied by participation in the actual process of change. Both spatial antidotes to machine space, such as calling a moritorium on its growth or even reversing it, and attempts to humanize existing space by reversing right of access, decentralizing control, and reducing the deadly quality of such space are recommended as activities and policies that are consistent with a spatial perspective. The initial step can be made through the venerable geographical act of mapping the expanding realm of machinekind, clearly part of the remaining terra incognita.