ENERGY AND EQUITY

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Ivan Illich
CIDOC
Apdo. 479
Cuernavaca, Mor.
Mexico

By the same author

CELEBRATION OF AWARENESS

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IDEAS IN PROGRESS

ENERGY AND EQUITY

Ivan Illich

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ABOUT THE AUTHOR

Ivan Illich was born in Vienna in 1926. He studied theology and philosophy at the Gregorian University in Rome and obtained a Ph.D. in history at the University of Salzburg. He came to the United States in 1951, where he served as assistant pastor in an Irish-Puerto Rican parish in New York City. From 1956 to 1960 he was assigned as vice-rector to the Catholic University of Puerto Rico, where he organized an intensive training centre for American priests in Latin American culture. Illich was a co-founder of the widely known and controversial Center for Intercultural Documentation (CIDOC) in Cuernavaca, Mexico, and since 1964 he has directed research seminars on 'Institutional Alternatives in a Technological Society', with special focus on Latin America. Ivan Illich's writings have appeared in *The New York Review*, *The Saturday Review*, *Esprit*, *Kursbuch*, *Siempre*, *America*, *Commonweal*, *Epreuves*, *Temps Modernes*, *Le Monde*, and *The Guardian*. He is the author of *Celebration of Awareness*, *Deschooling Society*, and *Tools for Conviviality*.

About the Editor of World Perspectives

Ruth Nanda Anshen, philosopher and editor, plans and edits *World Perspectives, Religious Perspectives, Credo Perspectives, Perspectives in Humanism,* and *The Science of Culture Series.* She also writes and lectures on the relationship of knowledge to the nature and meaning of man and existence. She is the author of *The Reality of the Devil: Evil in Man,* published by Harper & Row.

WORLD PERSPECTIVES

What This Series Means

It is the thesis of *World Perspectives* that man is in the process of developing a new consciousness which, in spite of his apparent spiritual and moral captivity, can eventually lift the human race above and beyond the fear, ignorance, and isolation which beset it today. It is to this nascent consciousness, to this concept of man born out of a universe perceived through a fresh vision of reality, that *World Perspectives* is dedicated.

My Introduction to this Series is not of course to be construed as a prefatory essay for each individual book. These few pages simply attempt to set forth the general aim and purpose of the Series as a whole. They try to point to the principle of permanence within change and to define the essential nature of man. as presented by those scholars who have been invited to participate in this intellectual and spiritual movement.

Man has entered a new era of evolutionary history, one in which rapid change is a dominant consequence. He is contending with a fundamental change, since he has intervened in the evolutionary process. He must now better appreciate this fact and then develop the wisdom to direct the process toward his fulfillment rather than toward his destruction. As he learns to apply his understanding of the physical world for practical purposes, he is, in reality, extending his innate capacity and augmenting his ability and his need to communicate as well as his ability to think and to create. And as a result, he is substituting a goal-directed evolutionary process in his struggle against environmental hardship for the slow, but effective, biological evolution which produced modern man through mutation and natural selection. By intelligent intervention in the evolutionary process man has greatly accelerated and greatly expanded

the range of his possibilities. But he has not changed the basic fact that it remains a trial and error process, with the danger of taking paths that lead to sterility of mind and heart, moral apathy and intellectual inertia; and even producing social dinosaurs unfit to live in an evolving world.

Only those spiritual and intellectual leaders of our epoch who have a paternity in this extension of man's horizons are invited to participate in this Series: those who are aware of the truth that beyond the divisiveness among men there exists a primordial unitive power since we are all bound together by a common humanity more fundamental than any unity of dogma; those who recognize that the centrifugal force which has scattered and atomized mankind must be replaced by an integrating structure and process capable of bestowing meaning and purpose on existence; those who realize that science itself, when not inhibited by the limitations of its own methodology, when chastened and humbled, commits man to an indeterminate range of yet undreamed consequences that may flow from it.

Virtually all of our disciplines have relied on conceptions which are now incompatible with the Cartesian axiom, and with the static world view we once derived from it. For underlying the new ideas, including those of modern physics, is a unifying order, but it is not causality; it is purpose, and not the purpose of the universe and of man, but the purpose *in* the universe and *in* man. In other words, we seem to inhabit a world of dynamic process and structure. Therefore we need a calculus of potentiality rather than one of probability, a dialectic of polarity, one in which unity and diversity are redefined as simultaneous and necessary poles of the same essence.

Our situation is new. No civilization has previously had to face the challenge of scientific specialization, and our response must be new. Thus this Series is committed to ensure that the spiritual and moral needs of man as a human being and the scientific and intellectual resources at his command for *life* may be brought into a productive, meaningful and creative harmony.

In a certain sense we may say that man now has regained his former geocentric position in the universe. For a picture of the Earth has been made available from distant space, from the lunar desert, and the sheer isolation of the Earth has become plain. This is as new and as powerful an idea in history as any that has ever been born in man's consciousness. We are all becoming seriously concerned with our natural environment. And this concern is not only the result of the warnings given by biologists, ecologists and conservationists. Rather it is the result of a deepening awareness that something new has happened, that the planet Earth is a unique and precious place. Indeed, it may not be a mere coincidence that this awareness should have been born at the exact moment when man took his first step into outer space.

This Series endeavors to point to a reality of which scientific theory has revealed only one aspect. It is the commitment to this reality that lends universal intent to a scientist's most original and solitary thought. By acknowledging this frankly we shall restore science to the great family of human aspirations by which men hope to fulfill themselves in the world community as thinking and sentient beings. For our problem is to discover a principle of differentiation and yet relationship lucid enough to justify and to purify scientific, philosophic and all other knowledge, both discursive and intuitive, by accepting their interdependence. This is the crisis in consciousness made articulate through the crisis in science. This is the new awakening.

Each volume presents the thought and belief of its author and points to the way in which religion, philosophy, art, science, economics, politics and history may constitute that form of human activity which takes the fullest and most precise account of variousness, possibility, complexity and difficulty. Thus *World Perspectives* endeavors to define that ecumenical power of the mind and heart which enables man through his mysterious greatness to re-create his life.

This Series is committed to a re-examination of all those sides of human endeavor which the specialist was taught to believe he could safely leave aside. It attempts to show the

structural kinship between subject and object; the indwelling of the one in the other. It interprets present and past events impinging on human life in our growing World Age and envisages what man may yet attain when summoned by an unbending inner necessity to the quest of what is most exalted in him. Its purpose is to offer new vistas in terms of world and human development while refusing to betray the intimate correlation between universality and individuality, dynamics and form, freedom and destiny. Each author deals with the increasing realization that spirit and nature are not separate and apart; that intuition and reason must regain their importance as the means of perceiving and fusing inner being with outer reality.

World Perspectives endeavors to show that the conception of wholeness, unity, organism is a higher and more concrete conception than that of matter and energy. Thus an enlarged meaning of life, of biology, not as it is revealed in the test tube of the laboratory but as it is experienced within the organism of life itself, is attempted in this Series. For the principle of life consists in the tension which connects spirit with the realm of matter, symbiotically joined. The element of life is dominant in the very texture of nature, thus rendering life, biology, a transempirical science. The laws of life have their origin beyond their mere physical manifestations and compel us to consider their spiritual source. In fact, the widening of the conceptual framework has not only served to restore order within the respective branches of knowledge, but has also disclosed analogies in man's position regarding the analysis and synthesis of experience in apparently separated domains of knowledge, suggesting the possibility of an ever more embracing objective description of the meaning of life.

Knowledge, it is shown in these books, no longer consists in a manipulation of man and nature as opposite forces, nor in the reduction of data to mere statistical order, but is a means of liberating mankind from the destructive power of fear, pointing the way toward the goal of the rehabilitation of the human will and the rebirth of faith and confidence in the human person. The works published also endeavor

to reveal that the cry for patterns, systems and authorities is growing less insistent as the desire grows stronger in both East and West for the recovery of a dignity, integrity and self-realization which are the inalienable rights of man who may now guide change by means of conscious purpose in the light of rational experience.

The volumes in this Series endeavor to demonstrate that only in a society in which awareness of the problems of science exists, can its discoveries start great waves of change in human culture, and in such a manner that these discoveries may deepen and not erode the sense of universal human community. The differences in the disciplines, their epistemological exclusiveness, the variety of historical experiences, the differences of traditions, of cultures, of languages, of the arts, should be protected and preserved. But the interrelationship and unity of the whole should at the same time be accepted.

The authors of *World Perspectives* are of course aware that the ultimate answers to the hopes and fears which pervade modern society rest on the moral fibre of man, and on the wisdom and responsibility of those who promote the course of its development. But moral decisions cannot dispense with an insight into the interplay of the objective elements which offer and limit the choices made. Therefore an understanding of what the issues are, though not a sufficient condition, is a necessary prerequisite for directing action toward constructive solutions.

Other vital questions explored relate to problems of international understanding as well as to problems dealing with prejudice and the resultant tensions and antagonisms. The growing perception and responsibility of our World Age point to the new reality that the individual person and the collective person supplement and integrate each other; that the thrall of totalitarianism of both left and right has been shaken in the universal desire to recapture the authority of truth and human totality. Mankind can finally place its trust not in a proletarian authoritarianism, not in a secularized humanism, both of which have betrayed the spiritual

property right of history, but in a sacramental brotherhood and in the unity of knowledge. This new consciousness has created a widening of human horizons beyond every parochialism, and a revolution in human thought comparable to the basic assumption, among the ancient Greeks, of the sovereignty of reason; corresponding to the great effulgence of the moral conscience articulated by the Hebrew prophets; analogous to the fundamental assertions of Christianity; or to the beginning of the new scientific era, the era of the science of dynamics, the experimental foundations of which were laid by Galileo in the Renaissance.

An important effort of this Series is to re-examine the contradictory meanings and applications which are given today to such terms as democracy, freedom, justice, love, peace, brotherhood and God. The purpose of such inquiries is to clear the way for the foundation of a genuine *world* history not in terms of nation or race or culture but in terms of man in relation to God, to himself, his fellow man and the universe, that reach beyond immediate self-interest. For the meaning of the World Age consists in respecting man's hopes and dreams which lead to a deeper understanding of the basic values of all peoples.

World Perspectives is planned to gain insight into the meaning of man, who not only is determined by history but who also determines history. History is to be understood as concerned not only with the life of man on this planet but as including also such cosmic influences as interpenetrate our human world. This generation is discovering that history does not conform to the social optimism of modern civilization and that the organization of human communities and the establishment of freedom and peace are not only intellectual achievements but spiritual and moral achievements as well, demanding a cherishing of the wholeness of human personality, the "unmediated wholeness of feeling and thought," and constituting a never-ending challenge to man, emerging from the abyss of meaninglessness and suffering, to be renewed and replenished in the totality of his life.

Justice itself, which has been "in a state of pilgrimage and crucifixion" and now is being slowly liberated from the grip of social and political demonologies in the East as well as in the West, begins to question its own premises. The modern revolutionary movements which have challenged the sacred institutions of society by protecting social injustice in the name of social justice are here examined and re-evaluated.

In the light of this, we have no choice but to admit that the *un*freedom against which freedom is measured must be retained with it, namely, that the aspect of truth out of which the night view appears to emerge, the darkness of our time, is as little abandonable as is man's subjective advance. Thus the two sources of man's consciousness are inseparable, not as dead but as living and complementary, an aspect of that "principle of complementarity" through which Niels Bohr has sought to unite the quantum and the wave, both of which constitute the very fabric of life's radiant energy.

There is in mankind today a counterforce to the sterility and danger of a quantitative, anonymous mass culture; a new, if sometimes imperceptible, spiritual sense of convergence toward human and world unity on the basis of the sacredness of each human person and respect for the plurality of cultures. There is a growing awareness that equality may not be evaluated in mere numerical terms but is proportionate and analogical in its reality. For when equality is equated with interchangeability, individuality is negated and the human person transmuted into a faceless mask.

We stand at the brink of an age of a world in which human life presses forward to actualize new forms. The false separation of man and nature, of time and space, of freedom and security, is acknowledged, and we are faced with a new vision of man in his organic unity and of history offering a richness and diversity of equality and majesty of scope hitherto unprecedented. In relating the accumulated wisdom of man's spirit to the new reality of the World Age, in articulating its thought and belief, *World Perspectives* seeks to encourage a renaissance of hope in society and of pride in man's decision as to what his destiny will be.

World Perspectives is committed to the recognition that all great changes are preceded by a vigorous intellectual re-evaluation and reorganization. Our authors are aware that the sin of *hubris* may be avoided by showing that the creative process itself is not a free activity if by free we mean arbitrary, or unrelated to cosmic law. For the creative process in the human mind, the developmental process in organic nature and the basic laws of the inorganic realm may be but varied expressions of a universal formative process. Thus *World Perspectives* hopes to show that although the present apocalyptic period is one of exceptional tensions, there is also at work an exceptional movement toward a compensating unity which refuses to violate the ultimate moral power at work in the universe, that very power upon which all human effort must at last depend. In this way we may come to understand that there exists an inherent independence of spiritual and mental growth which, though conditioned by circumstances, is never determined by circumstances. In this way the great plethora of human knowledge may be correlated with an insight into the nature of human nature by being attuned to the wide and deep range of human thought and human experience.

Incoherence is the result of the present disintegrative processes in education. Thus the need for *World Perspectives* expresses itself in the recognition that natural and man-made ecological systems require as much study as isolated particles and elementary reactions. For there is a basic correlation of elements in nature as in man which cannot be separated, which compose each other and alter each other mutually. Thus we hope to widen appropriately our conceptual framework of reference. For our epistemological problem consists in our finding the proper balance between our lack of an all-embracing principle relevant to our way of evaluating life and in our power to express ourselves in a logically consistent manner.

Our Judeo-Christian and Greco-Roman heritage, our Hellenic tradition, has compelled us to think in exclusive categories. But our *experience* challenges us to recognize a

totality richer and far more complex than the average observer could have suspected—a totality which compels him to think in ways which the logic of dichotomies denies. We are summoned to revise fundamentally our ordinary ways of conceiving experience, and thus, by expanding our vision and by accepting those forms of thought which also include nonexclusive categories, the mind is then able to grasp what it was incapable of grasping or accepting before.

Nature operates out of necessity; there is no alternative in nature, no will, no freedom, no choice as there is for man. Man must have convictions and values to live for, and this also is recognized and accepted by those scientists who are at the same time philosophers. For they then realize that duty and devotion to our task, be it a task of acting or of understanding, will become weaker and rarer unless guidance is sought in a metaphysics that transcends our historical and scientific views or in a religion that transcends and yet pervades the work we are carrying on in the light of day.

For the nature of knowledge, whether scientific or ontological, consists in reconciling *meaning* and *being*. And *being* signifies nothing other than the actualization of potentiality, self-realization which keeps in tune with the transformation. This leads to experience in terms of the individual; and to organization and patterning in terms of the universe. Thus organism and world actualize themselves simultaneously.

And so we may conclude that organism is *being* enduring in time, in fact in eternal time, since it does not have its beginning with procreation, nor with birth, nor does it end with death. Energy and matter in whatever form they may manifest themselves are transtemporal and transspatial and are therefore metaphysical. Man as man is summoned to know what is right and what is wrong, for emptied of such knowledge he is unable to decide what is better or what is worse.

World Perspectives hopes to show that human society is different from animal societies, which, having reached a certain stage, are no longer progressive but are dominated by routine and repetition. Thus man has discovered his own

nature, and with this self-knowledge he has left the state of nonage and entered manhood. For he is the only creature who is able to say not only "no" to life but "yes" and to make for himself a life that is human. In this decision lie his burden and his greatness. For the power of life or death lies not only in the tongue but in man's recently acquired ability to destroy or to create life itself, and therefore he is faced with unlimited and unprecedented choices for good and for evil that dominate our time. Our common concern is the very destiny of the human race. For man has now intervened in the process of evolution, a power not given to the pre-Socratics, nor to Aristotle, nor to the Prophets in the East or the West, nor to Copernicus, nor to Luther, Descartes, or Machiavelli. Judgments of value must henceforth direct technological change, for without such values man is divested of his humanity and of his need to collaborate with the very fabric of the universe in order to bestow meaning, purpose, and dignity upon his existence.

In spite of the infinite obligation of men and in spite of their finite power, in spite of the intransigence of nationalisms, and in spite of the homelessness of moral passions rendered ineffectual by the technological outlook, beneath the apparent turmoil and upheaval of the present, and out of the transformations of this dynamic period with the unfolding of a world-consciousness, the purpose of *World Perspectives* is to help quicken the "unshaken heart of well-rounded truth" and interpret the significant elements of the World Age now taking shape out of the core of that undimmed continuity of the creative proces which restores man to mankind while deepening and enhancing his communion with the universe.

RUTH NANDA ANSHEN

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FOREWORD

This essay is my summary of the discussions which took place in the course of two sessions—one in English, the other in Spanish—of a seminar that met at the Center for Intercultural Documentation (CIDOC) in Cuernavaca, Mexico. I am grateful to my colleagues who contributed ideas, facts and criticism. Copies of the working papers of our ongoing seminar on the history of thermodynamics as applied to transportation can be obtained from Isaac Rogel, CIDOC Librarian, Apdo. 479, Cuernavaca, Mor., Mexico. I owe special thanks to Dennis Sullivan for his editorial assistance on this essay.

The seminar on traffic was one of the preparatory meetings for a consultation which Valentina Borremans is now organizing at CIDOC for 1975–76. The consultation will focus on the interlocking

structure by which medical, legal, educational and energy-intensive agencies (such as those which produce transportation and housing) impose their paralysing monopoly on contemporary society. Although the context of our discussion is Latin America, its theme is pertinent to other regions.

During the next thirty months, the consultation ought to generate several more short working papers which are of general interest even though they are only vulnerable ideas in progress and in search of critique. Such essays cannot await the permanence of the book. They do not belong in the learned journal. They resist packaging in periodicals. The monopoly of publishers over the printed word too often pushes the tract into the mimeograph's limbo or seduces the author to reshape his text to fit the available vehicles. To break this monopoly Marion Boyars has shaped the format of this series, and Dennis Sullivan has offered to edit and submit to her what our consultation might produce.

ENERGY AND EQUITY

'El socialismo puede llegar solo en bicicleta'

José Antonio Viera-Gallo,
Assistant Secretary of Justice in the
Government of Salvador Allende

THE ENERGY CRISIS

It has recently become fashionable to insist on an impending energy crisis. This euphemistic term conceals a contradiction and consecrates an illusion. It masks the contradiction implicit in the joint pursuit of equity and industrial growth. It safeguards the illusion that machine power can indefinitely take the place of manpower. To face this contradiction and betray this illusion, it is urgent to clarify the reality that the language of crisis obscures: high quanta of energy degrade social relations just as inevitably as they destroy the physical milieu.

The proponents of an energy crisis confirm and continue to propagate a peculiar vision of man. According to this notion, man is born into prolonged dependence on slaves which he must painfully learn to master. If he does not employ

prisoners, then he needs motors to do most of his work. According to this doctrine, the well-being of a society can be measured by the number of years its members have gone to school and by the number of energy slaves they have thereby learned to command. This belief is common to the conflicting economic ideologies now in vogue. It is threatened by the obvious inequity, harriedness and impotence that appear everywhere once the voracious hordes of energy slaves outnumber people by a certain proportion. The energy crisis focuses concern on the scarcity of fodder for these slaves. I prefer to ask whether free men need them.

The energy policies adopted during the current decade will determine the range of social relationships a society will be able to enjoy by the year 2000. A low energy policy allows for a wide choice of life styles and cultures. If, on the other hand, a society opts for high energy consumption, its social relations must be dictated by technocracy and will be equally distasteful whether labelled capitalist or socialist.

At this moment, most societies—especially the poor ones—are still free to set their energy policies by any of three guidelines. Well-being can be identified with high amounts of per capita energy use, with high efficiency of energy transformation, or with the least possible use of mechanical energy by the most powerful member of society. The first approach would stress tight management of scarce and destructive fuels on behalf of industry, whereas the second would emphasize the retooling of industry in the interest of thermodynamic thrift.

Both attitudes necessarily imply huge public expenditures and increased social control; both rationalize the emergence of a computerized Leviathan, and both are at present widely discussed.

The possibility of a third option is barely noticed. While people have begun to accept ecological limits on maximum per capita energy use as a condition for physical survival, they do not yet think about the use of minimum feasible power as the foundation of any of various social orders that would be both modern and desirable. Yet only a ceiling on energy use can lead to social relations that are characterized by high levels of equity. The one option that is presently neglected is the only choice within the reach of all nations. It is also the only strategy by which a political process can be used to set limits on the power of even the most motorized bureaucrat. Participatory democracy postulates low energy technology. Only participatory democracy creates the conditions for rational technology.

What is generally overlooked is that equity and energy can grow concurrently only to a point. Below a threshold of per capita wattage, motors improve the conditions for social progress. Above this threshold, energy grows at the expense of equity. Further energy affluence then means decreased distribution of control over that energy.

The widespread belief that clean and abundant energy is the panacea for social ills is due to a political fallacy, according to which equity and energy consumption can be indefinitely correlated, at least under some ideal political conditions. Labouring under this illusion, we tend to discount any social

limit on the growth of energy consumption. But if ecologists are right to assert that non-metabolic power pollutes, it is in fact just as inevitable that, beyond a certain threshold, mechanical power corrupts. The threshold of social disintegration by high energy quanta is independent from the threshold at which energy conversion produces physical destruction. Expressed in horsepower, it is undoubtedly lower. This is the fact which must be theoretically recognized before a political issue can be made of the per capita wattage to which a society will limit its members.

Even if non-polluting power were feasible and abundant, the use of energy on a massive scale acts on society like a drug that is physically harmless but psychically enslaving. A community can choose between Methadone and 'cold turkey'—between maintaining its addiction to alien energy and kicking it in painful cramps—but no society can have a population that is at once autonomously active and hooked on progressively larger numbers of energy slaves.

In previous discussions, I have shown that, beyond a certain level of GNP, the cost of social control must rise faster than total output and become the major institutional activity within an economy. Therapy administered by educators, psychiatrists and social workers must converge with the designs of planners, managers and salesmen, and complement the services of security agencies, the military and the police. I now want to indicate one reason why increased affluence requires increased control over personnel. I argue that beyond a cer-

tain median per capita energy level, the political system and cultural context of any society must decay. Once the critical quantum of per capita energy is surpassed, education for the abstract goals of a bureaucracy must supplant the legal guarantees of personal and concrete initiative. This quantum is the limit of social order.

I will argue here that technocracy must prevail as soon as the ratio of mechanical power and metabolic energy oversteps a definite, identifiable threshold. The order of magnitude within which this threshold lies is largely independent from the level of technology applied, yet its very existence has slipped into the blindspot of social imagination in both rich and medium rich countries. Both the United States and Mexico have passed the critical divide. In both countries, further energy inputs increase inequality, inefficiency and personal impotence. Although one country has a per capita income of $500 and the other of nearly $5,000, huge vested interest in an industrial infrastructure prods both of them to further escalate the use of energy. As a result, both North American and Mexican ideologues put the label of 'energy crisis' on their frustration, and both countries are blinded to the fact that the threat of social breakdown is due neither to a shortage of fuel, nor to the wasteful, polluting and irrational use of available wattage, but to the attempt of industries to gorge society with energy quanta that inevitably degrade, deprive and frustrate most people.

A people can be just as dangerously overpowered by the wattage of its tools as by the caloric content

of its foods, but it is much harder to confess to a national overindulgence in wattage than to a sickening diet. The per capita wattage that is critical for social well-being lies within an order of magnitude which is far above the horsepower known to four-fifths of humanity and far below the power commanded by any Volkswagen driver. It eludes the underconsumer and the overconsumer alike. Neither is willing to face the facts. For the primitive, the elimination of slavery and drudgery depends on the introduction of appropriate modern technology, and for the rich, the avoidance of an even more horrible degradation depends on the effective recognition of a threshold in energy consumption beyond which technical processes begin to dictate social relations. Calories are both biologically and socially healthy only as long as they stay within the narrow range that separates enough from too much.

The so-called energy crisis is, then, a politically ambiguous issue. Public interest in the quantity of power and in the distribution of controls over the use of energy can lead in two opposite directions. On the one hand, questions can be posed that would open the way to political reconstruction by unblocking the search for a post-industrial, labour-intensive, low energy and high equity economy. On the other hand, hysterical concern with machine fodder can reinforce the present escalation of capital-intensive institutional growth, and carry us past the last turnoff from a hyper-industrial Armageddon. Political reconstruction presupposes the recognition of the fact that there exist *critical per capita quanta* beyond which energy can no longer be controlled

by political process. Social breakdown will be the inevitable outcome of ecological restraints on *total energy use* imposed by industrially-minded planners bent on keeping industrial production at some hypothetical maximum.

Rich countries like the United States, Japan or France might never reach the point of choking in their own waste, but only because their societies will have already collapsed into a socio-cultural energy coma. Countries like India, Burma and, for another short while at least, China, are in the inverse position of being still muscle-powered enough to stop short of an energy stroke. They could choose, right now, to stay within those limits to which the rich will be forced back at an enormous loss in their vested interest.

The choice of a minimum energy economy compels the poor to abandon distant expectations and the rich to recognize their vested interest as a ghastly liability. Both must reject the fatal image of man the slaveholder currently promoted by an ideologically stimulated hunger for more energy. In countries that were made affluent by industrial development, the energy crisis serves as a whip to raise the taxes which will be needed to substitute new, more sober and socially more deadly industrial processes for those that have been rendered obsolete by inefficient overexpansion. For the leaders of people who have been disowned by the same process of industrialization, the energy crisis serves as an alibi to centralize production, pollution and its control in a last-ditch effort to catch up with the more highly powered. By exporting their crisis and

by preaching the new gospel of Puritan energy worship, the rich do even more damage to the poor than they did by selling them the products of now outdated factories. As soon as a poor country accepts the doctrine that more energy more carefully managed will always yield more goods for more people, that country is hooked into the race for enslavement to maximum industrial outputs. Inevitably the poor abandon the option for rational technology when they choose to modernize their poverty by increasing their dependence on energy. Inevitably the poor reject the possibility of liberating technology and participatory politics when, together with maximum feasible energy use, they accept maximum feasible social control.

The energy crisis cannot be overwhelmed by more energy inputs. It can only be dissolved, along with the illusion that well-being depends on the number of energy slaves a man has at his command. For this purpose, it is necessary to identify the thresholds beyond which power corrupts, and to do so by a political process that associates the community in the search for limits. Because this kind of research runs counter to that now done by experts and for institutions, I shall call it counterfoil research. It has three steps. First, the need for limits on the per capita use of energy must be theoretically recognized as a social imperative. Then, the range must be located wherein the critical magnitude might be found. Finally, each community has to identify the levels of inequity, harrying and operant conditioning that its members are willing to accept in exchange for the satisfaction that comes of idolizing

powerful devices and joining in rituals directed by the professionals who control their operation.

The need for political research on socially optimal energy quanta can be clearly and concisely illustrated by an examination of modern traffic. The United States puts 45 per cent of its total energy into vehicles: to make them, run them and clear a right of way for them when they roll, when they fly and when they park. Most of this energy is to move people who have been strapped into place. For the sole purpose of transporting people, 250 million Americans allocate more fuel than is used by 1,300 million Chinese and Indians for all purposes. Almost all of this fuel is burnt in a rain dance of time-consuming acceleration. Poor countries spend less energy per person, but the percentage of total energy devoted to traffic in Mexico or in Peru is greater than in the USA, and it benefits a smaller percentage of the population. The size of this enterprise makes it both easy and significant to demonstrate the existence of socially critical energy quanta by the example of personal carriage.

In traffic, energy used over a specific period of time (power) translates into speed. In this case, the critical quantum will appear as a speed limit. Wherever this limit has been passed, the basic pattern of social degradation by high energy quanta has emerged. Once some public utility went faster than ± 15 mph, equity declined and the scarcity of both time and space increased. Motorized transportation monopolized traffic and blocked self-powered transit. In every Western country, passenger mileage on all types of conveyance increased

by a factor of a hundred within fifty years of building the first railroad. When the ratio of their respective power outputs passed beyond a certain value, mechanical transformers of mineral fuels excluded people from the use of their metabolic energy and forced them to become captive consumers of conveyance. This effect of speed on the autonomy of people is only marginally affected by the technological characteristics of the motorized vehicles employed or by the persons or entities who hold the legal titles to airlines, buses, railroads or cars. High speed is the critical factor which makes transportation socially destructive. A true choice among political systems and of desirable social relations is possible only where speed is restrained. Participatory democracy demands low energy technology, and free people must travel the road to productive social relations at the speed of a bicycle.*

* I speak about traffic for the purpose of illustrating the more general point of socially optimal energy use, and I restrict myself to the locomotion of persons, including their personal baggage and the fuel, materials and equipment used for the vehicle and the road. I purposely abstain from the discussion of two other types of traffic: merchandise and messages. A parallel argument can be made for both, but this would require a different line of reasoning, and I leave it for another occasion.

THE INDUSTRIALIZATION OF TRAFFIC

THE discussion of how energy is used to move people requires a formal distinction between transport and transit as the two components of traffic. By *traffic* I mean any movement of people from one place to another when they are outside of their homes. By *transit* I mean those movements that put human metabolic energy to use, and by *transport* that mode of movement which relies on other sources of energy. These energy sources will henceforth be mostly motors, since animals compete fiercely with men for their food in an over-populated world, unless they are thistle eaters like donkeys and camels.

As soon as people become tributaries of transport, not only when they travel for several days, but also on their daily trips, the contradictions between social justice and motorized power, between effective

movement and higher speed, between personal freedom and engineered routing, become poignantly clear. Enforced dependence on auto-mobile machines then denies a community of self-propelled people just those values supposedly procured by improved transportation.

People move well on their feet. This primitive means of getting around will, on closer analysis, appear quite effective when compared with the lot of people in modern cities or on industrialized farms. It will appear particularly attractive once it has been understood that modern Americans walk, on the average, as many miles as their ancestors—most of them through tunnels, corridors, parking lots and stores.

People on their feet are more or less equal. People solely dependent on their feet move on the spur of the moment, at three to four miles per hour, in any direction and to any place from which they are not legally or physically barred. An improvement on this native degree of mobility by new transport technology should be expected to safeguard these values and to add some new ones, such as greater range, time economies, comfort, or more opportunities for the disabled. So far this is not what has happened. Instead, the growth of the transportation industry has everywhere had the reverse effects. From the moment its machines could put more than a certain horsepower behind any one passenger, this industry has reduced equality among men, restricted their mobility to a system of industrially defined routes and created time scarcity of unprecedented severity. As the speed of their vehicles

crosses a threshold, citizens become transportation consumers on the daily loop that brings them back to their home, a circuit which the United States Department of Commerce calls a 'trip' as opposed to the 'travel' for which Americans leave home equipped with a toothbrush.

More energy fed into the transportation system means that more people move faster over a greater range in the course of every day. Everybody's daily radius expands at the expense of being able to drop in on an acquaintance or walk through the park on the way to work. Extremes of privilege are created at the cost of universal enslavement. An elite packs unlimited distance into a lifetime of pampered travel, while the majority spend a bigger slice of their existence on unwanted trips. The few mount their magic carpets to travel between distant points that their ephemeral presence renders both scarce and seductive, while the many are compelled to trip further and faster and to spend more time preparing for and recovering from their trips.

In the United States, four-fifths of all man-hours on the road are those of commuters and shoppers who hardly ever get into a plane, while four-fifths of the mileage flown to conventions and resorts is covered year after year by the same one and a half per cent of the population, usually those who are either well-to-do or professionally trained to do good. The speedier the vehicle, the larger the subsidy it gets from regressive taxation. Barely 0·2 per cent of the entire US population can engage in self-chosen air travel more than once a year, and few other countries can support a jet set which is that large.

The captive tripper and the reckless traveller become equally dependent on transport. Neither can do without it. Occasional spurts to Acapulco or to a Party Congress dupe the ordinary passenger into believing that he has made it into the shrunk world of the powerfully rushed. The occasional chance to spend a few hours strapped into a high-powered seat makes him an accomplice in the distortion of human space, and prompts him to consent to the design of his country's geography around vehicles rather than around people. Man has evolved physically and culturally together with his cosmic niche. What for animals is their environment he has learned to make into his home. His self-image requires as its complement a life-space and a life-time integrated by the pace at which he moves. If that relationship is determined by the velocity of vehicles rather than by the movement of people, man the architect is reduced to the status of a mere commuter.

The typical American male devotes more than 1,600 hours a year to his car. He sits in it while it goes and while it stands idling. He parks it and searches for it. He earns the money to put down on it and to meet the monthly instalments. He works to pay for petrol, tolls, insurance, taxes and tickets. He spends four of his sixteen waking hours on the road or gathering his resources for it. And this figure does not take into account the time consumed by other activities dictated by transport: time spent in hospitals, traffic courts and garages; time spent watching automobile commercials or attending consumer education meetings to improve the

quality of the next buy. The model American puts in 1,600 hours to get 7,500 miles: less than five miles per hour. In countries deprived of a transportation industry, people manage to do the same, walking wherever they want to go, and they allocate only three to eight per cent of their society's time budget to traffic instead of 28 per cent. What distinguishes the traffic in rich countries from the traffic in poor countries is not more mileage per hour of life-time for the majority, but more hours of compulsory consumption of high doses of energy, packaged and unequally distributed by the transportation industry.

SPEED-STUNNED IMAGINATION

PAST a certain threshold of energy consumption, the transportation industry dictates the configuration of social space. Motorways expand, driving wedges between neighbours and removing fields beyond the distance a farmer can walk. Ambulances take clinics beyond the few miles a sick child can be carried. The doctor will no longer come to the house, because vehicles have made the hospital into the right place to be sick. Once heavy lorries reach a village high in the Andes, part of the local market disappears. Later, when the high school arrives at the plaza along with the paved highway, more and more of the young people move to the city, until not one family is left which does not long for a reunion with someone hundreds of miles away, down on the coast.

Equal speeds have equally distorting effects on the

perception of space, time and personal potency in rich and in poor countries, however different the surface appearances might be. Everywhere, the transportation industry shapes a new kind of man to fit the new geography and the new schedules of its making. The major difference between Guatemala and Kansas is that in Central America some people are still exempt from all contact with vehicles and are, therefore, still not degraded by their dependence on them.

The product of the transportation industry is the habitual passenger. He has been boosted out of the world in which people still move on their own, and he has lost the sense that he stands at the centre of his world. The habitual passenger is conscious of the exasperating time scarcity that results from daily recourse to the cars, trains, buses, undergrounds and lifts that force him to cover an average of twenty miles each day, frequently crossing his path within a radius of less than five miles. He has been lifted off his feet. No matter if he goes by underground or jetplane he feels slower and poorer than someone else and resents the shortcuts taken by the priviledged few who can escape the frustrations of traffic. If he is cramped by the timetable of his commuter train, he dreams of a car. If he is exhausted by the rush hour, he envies the speed capitalist who drives against the traffic. If he must pay for his car out of his own pocket, he knows full well that the commanders of corporate fleets send the fuel bill to the company and write off the rented car as a business expense. The habitual passenger is caught at the wrong end of growing inequality, time scarcity and

personal impotence, but he can see no way out of this bind except to demand more of the same: more traffic by transport. He stands in wait of technical changes in the design of vehicles, roads and schedules; or else he expects a revolution to produce mass rapid transport under public control. In neither case does he calculate the price of being hauled into a better future. He forgets that he is the one who will pay the bill, either in fares or in taxes. He overlooks the hidden costs of replacing private cars with equally rapid public transport.

The habitual passenger cannot grasp the folly of traffic based overwhelmingly on transport. His inherited perceptions of space and time and of personal pace have been industrially deformed. He has lost the power to conceive of himself outside of the passenger role. Addicted to being carried along, he has lost control over the physical, social and psychic powers that reside in man's feet. The passenger has come to identify territory with the untouchable landscape through which he is rushed. He has become impotent to establish his domain, mark it with his imprint and assert his sovereignty over it. He has lost confidence in his power to admit others into his presence and to share space consciously with them. He can no longer face the remote by himself. Left on his own, he feels immobile.

The habitual passenger must adopt a new set of beliefs and expectations if he is to feel secure in the strange world where both liaisons and loneliness are products of conveyance. To 'gather' for him means to be brought together by vehicles. He comes

to believe that political power grows out of the capacity of a transportation system, and in its absence is the result of access to the television screen. He takes freedom of movement to be the same as one's claim on propulsion. He believes that the level of democratic process correlates to the power of transportation and communications systems. He has lost faith in the political power of the feet and of the tongue. As a result, what he wants is not more liberty as a citizen but better service as a client. He does not insist on his freedom to move and to speak to people but on his claim to be shipped and to be informed by media. He wants a better product rather than freedom from servitude to it. It is vital that he come to see that the acceleration he demands is self-defeating, and that it must result in a further decline of equity, leisure and autonomy.

NET TRANSFER OF LIFETIME

UNCHECKED speed is expensive and progressively fewer can afford it. Each increment in the velocity of a vehicle results in an increase in the cost of propulsion, track-construction and—most dramatically—in the space the vehicle devours while it is on the move. Past a certain threshold of energy consumption for the fastest passenger, a worldwide class structure of speed capitalists is created. The exchange value of time becomes dominant, and this is reflected in language: time is spent, saved, invested, wasted and employed. As societies put price tags on time, equity and vehicular speed correlate inversely.

High speed capitalizes a few people's time at an enormous rate but, paradoxically, it does this at a high cost in time for all. In Bombay, only a very few people own cars. They can reach a provincial

capital in one morning and make the trip once a week. Two generations ago, this would have been a week-long trek once a year. They now spend more time on more trips. But these same few also disrupt, with their cars, the traffic flow of thousands of bicycles and pedicabs that move through downtown Bombay at a rate of effective locomotion superior to that of downtown Paris, London or New York. The compounded, transport-related time expenditure within a society grows much faster than the time economies made by a few people on their speedy excursions. Traffic grows indefinitely with the availability of transports. Beyond a critical threshold, the output of the industrial complex established to move people costs a society more time than it saves. The marginal utility of an increment in the speed of a small number of people has for its price the growing marginal disutility of this acceleration for the great majority.

Beyond a critical speed, no one can save time without forcing another to lose it. The man who claims a seat in a faster vehicle insists that his time is worth more than that of the passenger in a slower one. Beyond a certain velocity, passengers become consumers of other people's time, and accelerating vehicles become the means for effecting a net transfer of life-time. The degree of transfer is measured in quanta of speed. This time-grab despoils those who are left behind, and since they are the majority, it raises ethical issues of a more general nature than kidney dialysis or organ transplants.

Beyond a certain speed, motorized vehicles create remoteness which they alone can shrink. They create

distances for all and shrink them for only a few. A new dirt road through the wilderness brings the city within view, but not within reach, of most Brazilian subsistence farmers. The new expressway expands Chicago, but it sucks those who are well-wheeled away from a downtown that decays into a ghetto.

Man's speed remained unchanged from the Age of Cyrus to the Age of Steam. News could not travel more than a hundred miles per day, no matter how the message was carried. Neither the Inca's runners nor the Venetian galley, the Persian horseman or the mail coach under Louis XIV, could break the barrier. Soldiers, explorers, merchants and pilgrims moved at twenty miles per day. In Valéry's words, Napoleon still had to move at Caesar's slowness: *Napoléon va à la même lenteur que César*. The Emperor knew that 'public prosperity is measured by the income of the coaches': *On mésure la prospérité publique aux comptes des diligences*, but he could barely speed them up. Paris–Toulouse had required about 200 hours in Roman times, and the scheduled stagecoach still took 158 hours in 1782. Only the nineteenth century accelerated man. By 1830, the trip had been reduced to 110 hours, but at a new cost. In the same year, 4,150 stagecoaches overturned in France, causing more than a thousand deaths. Then the railroad brought a sudden change. By 1855, Napoleon III claimed to have travelled an average of 96 kilometres per hour on the train between Paris and Marseilles. Within one generation, the average distance travelled each year per Frenchman increased one hundred and thirty times, and

Britain's railroad network reached its greatest expansion. Passenger trains attained their optimum cost calculated in terms of time spent for their maintenance and use.

With further acceleration, transportation began to dominate traffic, and speed began to erect a hierarchy of destinations. By now, each set of destinations corresponds to a specific level of speed and defines a certain passenger class. Each circuit of terminal points degrades those pegged at a lower number of miles per hour. Those who must get around on their own power have been redefined as underdeveloped outsiders. Tell me how fast you go and I'll tell you who you are. If you can corner the taxes which fuel the Concorde, you are certainly at the top.

Over the last two generations, the vehicle has become the sign of career achievement, just as the school has become the sign of starting advantage. At each new level, the concentration of power must produce its own kind of rationale. So, for example, the reason that is usually given for spending public money to make a man travel more miles in less time each year is the still greater investment that was made to keep him more years in school. His putative value as a capital-intensive production tool sets the rate at which he is being shipped. Other ideological labels besides 'a good education' are just as useful for opening the cabin door to luxuries paid for by others. If the Thought of Chairman Mao must now be rushed around China by jet, this can only mean that two classes are needed to fuel what his revolution has become, one of them living in the geography

of the masses and the other in the geography of the cadres. The suppression of intermediary levels of speed in Popular China has certainly made the concentration of power more efficient and rational, but it also underscores the new difference in value between the time of the bullock driver and the time of the jet-driven. Accelerating speed inevitably concentrates horsepower under the seats of a few and compounds the increasing time-lack of most commuters with the further sense that they are lagging behind.

The need for unequal privilege in an industrial society is generally advocated by means of an argument with two sides. The hypocrisy of this argument is clearly betrayed by acceleration. Privilege is accepted as the necessary pre-condition to improve the lot of a growing total population, or it is advertised as the instrument for raising the standards of a deprived minority. In the long run, accelerating transportation does neither. It only creates a universal demand for motorized conveyance, and puts previously unimaginable distances between the various layers of privilege. Beyond a certain point, more energy means less equity.

THE INEFFECTIVENESS OF ACCELERATION

It should not be overlooked that top speeds for a few exact a different price than high speeds for all. Social classification by levels of speed enforces a net transfer of power: the poor work and pay to get left behind. But if the middle classes of a speed society may be tempted to ignore discrimination, they should not neglect the rising marginal disutilities of transportation and their own loss of leisure. High speeds for all mean that everybody has less time for himself as the whole society spends a growing slice of its time budget on moving people. Vehicles running over the critical speed not only tend to impose inequality, they also inevitably establish a self-serving industry that hides an inefficient system of locomotion under apparent technological sophistication. I will argue that a speed limit is necessary not only to safeguard equity;

it is equally a condition for increasing the total distance travelled within a society, while decreasing the total time that travel takes.

There is little research available on the impact of vehicles on the twenty-four-hour time budget of individuals and societies. From transportation studies, we get statistics on the cost of time per mile, on the value of time measured in dollars or in length of trips. But these statistics tell us nothing about the hidden costs of transportation: about how traffic nibbles away at life-time, about how vehicles devour space, about the multiplication of trips made necessary by the existence of vehicles, or about the time spent directly and indirectly preparing for locomotion. Further, there is no available measure of the even more deeply buried costs of transport, such as higher rent to live in areas convenient to the flow of traffic, or the cost of protecting these areas from the noise, pollution and danger to life and limb that vehicles create. The lack of an account of expenditures from the social time budget should not lead us to believe, however, that such an accounting is impossible, nor should it prevent our drawing conclusions from the little that we do know.

From our limited information it appears that everywhere in the world, after some vehicle broke the speed barrier of 15 mph, time scarcity related to traffic began to grow. After industry had reached this threshold of per capita output, transport made of man a new kind of waif: a being constantly absent from a destination he cannot reach on his own but must reach within the day. By now, people work a substantial part of every day to earn the money

without which they could not even get to work. The time a society spends on transportation grows in proportion to the speed of its fastest public conveyance. Japan now leads the United States in both areas. Life-time gets cluttered up with activities generated by traffic as soon as vehicles crash through the barrier that guards people from dislocation and space from distortion.

Whether the vehicle that speeds along the public freeway is owned by the state or by an individual has little to do with the time scarcity and overprogramming that rise with every increment in speed. Buses use one-third of the fuel which cars burn to carry one man over a given distance. Commuter trains are up to ten times more efficient than cars. Both could become even more efficient and less polluting. If publicly owned and rationally managed, they could be so scheduled and routed that the privileges they presently provide under private ownership and incompetent organization would be considerably cut. But as long as any system of vehicles imposes itself on the public by its unlimited top speed, the public is left to choose between spending more time to pay for more people to be carried from station to station, and paying less taxes so that even fewer people can travel in much less time much further than others. The order of magnitude of the top speed which is permitted within a transportation system determines the slice of its time budget that an entire society spends on traffic.

THE RADICAL MONOPOLY OF INDUSTRY

A desirable ceiling on the velocity of movement cannot be usefully discussed without returning to the distinction between self-powered *transit* and motorized *transport*, and comparing the contribution each component makes relative to the total locomotion of people, which I have called *traffic*.

Transport stands for the capital-intensive mode of traffic and transit indicates the labour-intensive mode. Transport is the product of an industry whose clients are passengers. It is an industrial commodity and therefore scarce by definition. Improvement of transport always takes place under conditions of scarcity that become more severe as the speed—and with it the cost—of the service increases. Conflict about insufficient transport tends to take the form of a zero-sum game where one wins only if another

loses. At best, such a conflict allows for the solution of the Prisoner's Dilemma: by cooperating with their jailer, both prisoners get off with less time in the cell.

Transit is not the product of an industry, but the independent enterprise of transients. It has use value by definition but need not have any exchange value. The ability to engage in transit is native to man and more or less equally distributed among healthy people of the same age. The exercise of this ability can be restricted by depriving some class of people of the right to take a straight route, or because a population lacks shoes or pavements. Conflict about unsatisfactory transit conditions tends to take, therefore, the form of a non-zero-sum game in which everyone comes out ahead—not only the people who get the right to walk through a formerly walled property, but also the owner who now gets a road.

Total traffic is the result of two profoundly distinct modes of production. These can reinforce each other harmoniously only as long as the autonomous outputs are protected against the encroachment of the industrial product.

The harm done by contemporary traffic is due to the monopoly of transport. The allure of speed has deceived the passenger into accepting the promises made by an industry that produces capital-intensive traffic. He is convinced that high-speed vehicles have allowed him to progress beyond the limited autonomy he enjoyed when moving under his own power. He has allowed planned transport to predominate over the alternative of labour-intensive

transit. Destruction of the physical environment is the least noxious effect of this concession. The far more bitter results are the multiplication of psychic frustration, the growing disutilities of continued production, and subjection to an inequitable transfer of power—all of which are manifestations of a distorted relationship between life-time and life-space. The passenger who agrees to live in a world monopolized by transport becomes a harassed, overburdened consumer of distances whose shape and length he can no longer control.

Every society that imposes compulsory speed submerges transit to the profit of transport. Wherever not only privilege but also elementary necessities are denied to those who do not use high-speed conveyances, an involuntary acceleration of personal rhythms is imposed. Industry dominates traffic as soon as daily life comes to depend on motorized trips.

This profound control of the transportation industry over natural mobility constitutes a monopoly much more pervasive than either the commercial monopoly Ford might win over the automobile market, or the political monopoly car manufacturers might wield against the development of trains and buses. Because of its hidden, entrenched and structuring nature, I call this a *radical monopoly*. Any industry exercises this kind of deep-seated monopoly when it becomes the dominant means of satisfying needs that formerly occasioned a personal response. The compulsory consumption of a high-powered commodity (motorized transport) restricts the conditions for enjoying an abundant use value

(the innate capacity for transit). Traffic serves here as the paradigm of a general economic law: *Any industrial product that comes in per capita quanta beyond a given intensity exercises a radical monopoly over the satisfaction of a need.* Beyond some point, compulsory schooling destroys the environment for learning, medical delivery systems dry up the non-therapeutic sources of health, and transportation smothers traffic.

Radical monopoly is first established by a rearrangement of society for the benefit of those who have access to the larger quanta, then it is enforced by compelling all to consume the minimum quantum in which the output is currently produced. Compulsory consumption will take on a different appearance in industrial branches where information dominates, such as education or medicine, than it will in those branches where quanta can be measured in British thermal units, such as housing, clothing or transport. The industrial packaging of values will reach critical intensity at different points with different products but, for each major class of outputs, the threshold occurs within an order of magnitude that is theoretically identifiable. The fact that it is possible theoretically to determine the range of speed within which transportation develops a radical monopoly over traffic does not mean that it is possible theoretically to determine just how much of such a monopoly any given society will tolerate. The fact that it is possible to identify a level of compulsory instruction at which learning by seeing and doing declines does not enable the theorist to identify the specific

pedagogical limits to the division of labour that a culture will tolerate. Only recourse to juridical and, above all, to political process can lead to the specific, though provisional, measures by which speed or compulsory education will actually be limited in a given society. The magnitude of voluntary limits is a matter of politics; the encroachment of radical monopoly can be pinpointed by social analysis.

A branch of industry does not impose a radical monopoly on a whole society by the simple fact that it produces scarce products, or because it drives competing industries off the market, but rather by virtue of its acquired ability to create and shape the need which it alone can satisfy.

Shoes are scarce all over Latin America and many people never wear them. They walk on the bare soles of their feet, or wear the world's widest variety of excellent sandals, supplied by a range of artisans. Their transit is in no way restricted by their lack of shoes. But in some countries of South America people are compelled to be shod ever since access to schools, jobs and public services was denied to the barefoot. Teachers or party officials define the lack of shoes as a sign of indifference toward 'progress'. Without any intentional conspiracy between the promoters of national development and the shoe industry, the barefoot in these countries are now barred from any office.

Schools, like shoes, were scarce at all times. But it was never the small number of privileged pupils that turned the school into an obstacle for learning. Only when laws were enacted to make schools both compulsory and free did the educator assume

the power to deny learning opportunities on the job to the underconsumer of educational therapies. Only when school attendance had become obligatory did it become feasible to impose on all a progressively more complex artificial environment into which the unschooled and unprogrammed do not fit.

The potential of a radical monopoly is unmistakeable in the case of traffic. Imagine what would happen if the transportation industry could somehow distribute its output more adequately: a traffic Utopia of free *rapid* transportation for all would inevitably lead to a further expansion of traffic's domain over human life. What could such a Utopia look like? Traffic would be organized exclusively around public transportation systems. It would be financed by a progressive tax calculated on income and on the proximity of one's residence to the next terminal and to the job. It would be designed so that everybody could occupy any seat on a first-come, first-served basis: the doctor, the vacationer and the President would not be assigned any priority of person. In this fool's paradise, all passengers would be equal, but they would be just as equally captive consumers of transport. Each citizen of a motorized Utopia would be deprived of the use of his feet and drafted into the servitude of proliferating networks of transportation.

Certain would-be miracle makers disguised as architects offer a specious escape from the paradox of speed. By their standards, acceleration imposes inequities, time loss and controlled schedules only because people do not yet live in those patterns and

orbits into which vehicles can best place them. These futuristic architects would house and occupy people in self-sufficient units of towers interconnected by tracks for high-speed capsules. Soleri, Doxiadis or Fuller would solve the problem created by high-speed transport by identifying the entire human habitat with the problem. Rather than asking how the earth's surface can be preserved for people, they ask how reservations for necessary people can be established on an earth that has been reshaped for the sake of industrial outputs.

THE ELUSIVE THRESHOLD

ANY traffic-optimal speed for transport seems capricious or fanatical to the confirmed passenger, whereas it looks like the flight of the bird to the donkey driver. Four or six times the speed of a man on foot constitutes a threshold too low to be deemed worthy of consideration by the habitual passenger and too high to convey the sense of a *limit* to the three-quarters of humanity who still get around on their own power.

All those who plan other people's housing, transportation or education belong to the passenger class. Their claim to power is derived from the value their employers place on acceleration. Social scientists can build a computer model of traffic in Calcutta or Santiago, and engineers can design monorail webs according to abstract notions of traffic flow. Since these planners are true believers in problem

solving by industry, the real solution for traffic congestion is beyond their grasp. Their belief in the effectiveness of power blinds them to the disproportionately greater effectiveness of abstaining from its use. Traffic engineers have yet to combine in one simulation model the mobility of people with that of vehicles. The engineer cannot conceive the possibility of renouncing speed and slowing down for the sake of permitting optimal traffic flow. He would never entertain the thought of programming his computer on the stipulation that no motorized vehicle within any city should ever overtake the speed of a velocipede. The development expert who looks down compassionately from his Land-Rover on the Indian peasant driving his pigs to market refuses to acknowledge the relative advantage of feet. The expert tends to forget that this man has dispensed ten others in his village from spending time on the road, whereas the engineer and every member of his family separately devote a major part of every day to being in traffic. For a man who believes that human mobility must be conceived in terms of indefinite progress, there can be no optimal level of traffic but only passing consensus on a given level of technical development.

Most Mexicans, not to speak of Indians and Chinese, are in a position inverse to that of the confirmed passenger. The critical threshold is entirely beyond what all but a few of them know or expect. They still belong to the class of the self-powered. Some of them have a lingering memory of a motorized adventure, but most of them have no personal experience of travelling at or above the

critical speed. In the two typical Mexican states of Guerrero and Chiapas, less than one per cent of the population moved even once over ten miles in less than one hour during 1970. The vehicles into which people in these areas are sometimes crowded render traffic indeed more convenient, but barely faster than the speed of a bicycle. The third class bus does not separate the farmer from his pig, and it takes them both to market without inflicting any loss of weight, but this acquaintance with motorized 'comfort' does not amount to dependence on destructive speed.

The order of magnitude in which the critical threshold of speed can be found is too low to be taken seriously by the passenger, and too high to concern the peasant. It is so obvious it cannot be easily seen. The proposal of a limit to speed within this order of magnitude engenders stubborn opposition. It exposes the addiction of industrialized men to consuming ever higher doses of energy, while it asks those who are still sober to abstain from something they have yet to taste.

To propose counterfoil research is not only a scandal, it is also a threat. Simplicity threatens the expert, who supposedly understands just why the commuter train runs at 8:15 and 8:41 and why it must be better to use fuel with certain additives. That a political process could identify a natural magnitude, both inescapable and limited, is an idea that lies outside the passenger's world of verities. He has let respect for specialists he doesn't even know turn into unthinking submission. If a political resolution could be found for problems created by

experts in the field of traffic, then perhaps the same remedy could be applied to problems of education, medicine or urbanization. If the order of magnitude of traffic optimal vehicular velocities could be determined by laymen actively participating in an ongoing political process, then the foundation on which the framework of every industrial society is built would be shattered. To propose such research is politically subversive. It puts in question the overarching consensus on the need for more transportation which now allows the proponents of public ownership to define themselves as political adversaries of the proponents of private enterprise.

DEGREES OF SELF-POWERED MOBILITY

A CENTURY ago, the ball-bearing was invented. It reduced the coefficient of friction by a factor of a thousand. By applying a well-calibrated ball-bearing between two neolithic millstones, a man could now grind in a day what took his ancestors a week. The ball-bearing also made possible the bicycle, allowing the wheel—probably the last of the great neolithic inventions—finally to become useful for self-powered mobility.

Man, unaided by any tool, gets around quite efficiently. He carries one gram of his weight over a kilometre in ten minutes by expending 0·75 calories. Man on his feet is thermodynamically more efficient than any motorized vehicle and most animals. For his weight, he performs more work in locomotion than rats or oxen, less than horses or sturgeon. At this rate of efficiency man settled the

world and made its history. At this rate peasant societies spend less than five per cent and nomads less than eight per cent of their respective social time budgets outside the home or the encampment.

Man on a bicycle can go three or four times faster than the pedestrian, but uses five times less energy in the process. He carries one gram of his weight over a kilometre of flat road at an expense of only 0·15 calories. The bicycle is the perfect transducer to match man's metabolic energy to the impedance of locomotion. Equipped with this tool, man outstrips the efficiency of not only all machines, but all other animals as well.

The invention of the ball-bearing, the tangent-spoked wheel and the pneumatic tyre taken together can be compared to only three other events in the history of transportation. The invention of the wheel at the dawn of civilization took the load off man's back and put it onto the barrow. The invention and simultaneous application, during the European Middle Ages, of stirrup, shoulder harness and horseshoe increased the thermodynamic efficiency of the horse by a factor of up to five, and changed the economy of medieval Europe: it made frequent ploughing possible and thus introduced rotation agriculture; it brought more distant fields into the reach of the peasant, and thus permitted landowners to move from six-family hamlets into 100-family villages, where they could live around the church, the square, the jail and—later—the school; it allowed the cultivation of northern soils and shifted the centre of power into cold climates. The building of the first ocean-going vessels by the

Portuguese in the fifteenth century, under the aegis of developing European capitalism, laid the solid foundations for a globe-spanning culture and market.

The invention of the ball-bearing signalled a fourth revolution. It created an option between more freedom in equity and more speed. The bearing is an equally fundamental ingredient of two new types of locomotion, respectively symbolized by the bicycle and the car. The bicycle lifted man's automobility into a new order, beyond which progress is theoretically not possible. In contrast, the accelerating individual capsule enabled societies to engage in a ritual of progressively paralysing speed.

The monopoly of a ritual application over a potentially useful device is nothing new. Thousands of years ago, the wheel took the load off the carrier-slave, but it did so only on the Eurasian landmass. In Mexico, the wheel was well-known, but never applied to transport. It served exclusively for the construction of carriages for toy gods. The taboo on wheelbarrows in America before Cortés is no more puzzling than the taboo on bicycles in modern traffic.

It is by no means necessary that the invention of the ball-bearing continue to serve the increase of energy use, and thereby produce time scarcity, space consumption and class privilege. If the new order of self-powered mobility offered by the bicycle were protected against devaluation, paralysis and risk to the limbs of the rider, it would be possible to guarantee optimal shared mobility to all

people and put an end to the imposition of maximum privilege and exploitation. It would be possible to control the patterns of urbanization if the organization of space were constrained by the power man has to move through it.

Bicycles are not only thermodynamically efficient, they are also cheap. With his much lower salary, the Chinese acquires his durable bicycle in a fraction of the working hours an American devotes to the purchase of his obsolescent car. The cost of public utilities needed to facilitate bicycle traffic versus the price of an infrastructure tailored to high speeds is proportionately even less than the price differential of the vehicles used in the two systems. In the bicycle system, engineered roads are necessary only at certain points of dense traffic, and people who live far from the surfaced path are not thereby automatically isolated as they would be if they depended on cars or trains. The bicycle has extended man's radius without shunting him onto roads he cannot walk. Where he cannot ride his bike he can usually push it.

The bicycle also uses little space. Eighteen bikes can be parked in the place of one car, thirty of them can move along in the space devoured by a single automobile. It takes two lanes of a given size to move 40,000 people across a bridge in one hour by using modern trains, four to move them on buses, 12 to move them in their cars, and only one lane for them to pedal across on bicycles. Of all these vehicles, only the bicycle really allows people to go from door to door without walking. The cyclist can reach new destinations of his choice without his

tool creating new locations from which he is barred.

Bicycles let people move with greater speed without taking up significant amounts of scarce space, energy or time. They can spend fewer hours on each mile and still travel more miles in a year. They can get the benefit of technological breakthroughs without putting undue claims on the schedules, energy or space of others. They become masters of their own movements without blocking those of their fellows. Their new tool creates only those demands which it can also satisfy. Every increase in motorized speed creates new demands on space and time. The use of the bicycle is self-limiting. It allows people to create a new relationship between their life-space and their life-time, between their territory and the pulse of their being, without destroying their inherited balance. The advantages of modern self-powered traffic are obvious, and ignored. That better traffic runs faster is asserted, but never proved. Before they ask people to pay for it, those who propose acceleration should try to display the evidence for their claim.

A grizzly contest between bicycles and motors has just come to an end. In Vietnam, a hyperindustrialized army tried to conquer, but could not overcome, a people organized around bicycle speed. The lesson should be clear. High energy armies can annihilate people—both those they defend and those against whom they are launched, but they are of very limited use to a people which defends itself. It remains to be seen if the Vietnamese will apply what they learned in war to an economy of peace, if they will be willing to protect the values

that made their victory possible. The dismal likelihood is that the victors, for the sake of industrial progress and increased energy consumption, will tend to defeat themselves by destroying that structure of equity, rationality and autonomy into which American bombers had forced them by depriving them of fuels, motors and roads.

DOMINANT
V.
SUBSIDIARY MOTOR

MEN are born almost equally mobile. Their natural ability speaks for the personal liberty of each one to go wherever he or she wants to go. Citizens of a society founded on the notion of equity will demand the protection of this right against any abridgement. It should be irrelevant to them by what means the exercise of personal mobility is denied, whether by imprisonment, bondage to an estate, revocation of a passport, or enclosure within an environment that encroaches on a person's native ability to move in order to make him a consumer of transport. This inalienable right of free movement does not lapse just because most of our contemporaries have strapped themselves into ideological seat belts. Man's natural capacity for transit emerges as the only yardstick by which to measure the contribution transport can make to

traffic: there is only so much transport that traffic can bear. It remains to be outlined how we can distinguish those forms of transport that cripple the power to move from those that enhance it.

Transportation can abridge traffic in three ways: by breaking its flow, by creating isolated sets of destinations, and by increasing the loss of time due to traffic. I have already argued that the key to the relation between transport and traffic is the speed of vehicles. I have described how, past a certain threshold of speed, transport has gone on to obstruct traffic in these three ways. It blocks mobility by cluttering up the environment with vehicles and roads. It transforms geography into a pyramid of circuits sealed off from one another according to levels of acceleration. It expropriates life-time at the behest of speed.

If beyond a certain threshold transport obstructs traffic, the inverse is also true: below some level of speed, motorized vehicles can complement or improve traffic by permitting people to do things they could not do on foot or on bicycle. Motors can be used to transport the sick, the lame, the old and the just plain lazy. Motorpulleys can lift people over hills, but they can do so peacefully only if they do not push the climber off the path. Trains can extend the range of travel, but only if they give people equal opportunity to come closer to each other. A well-developed transportation system running at top speeds of 25 mph would have allowed Fix to chase Phileas Fogg around the world in less than half of 80 days. The time engaged in travel must be, as much as possible, the traveller's own: only

insofar as motorized transport remains limited to speeds which leave it subsidiary to autonomous transit can a traffic-optimal transportation system be developed.

A limit on the power and therefore on the speed of motors does not by itself insure those who are weaker against exploitation by the rich and powerful, who can still devise means to live and work at better located addresses, travel with retinue in plush carriages, and reserve a special lane for doctors and members of the central committee. But at a sufficiently limited maximum speed, this is an unfairness which can be reduced or even corrected by a combination of taxes and technological devices. At unlimited top speed neither public ownership of the means of transportation nor technical improvements in their control can ever eliminate growing and unequal exploitation. A transportation industry is the key to optimal production of traffic, but only if it does not exercise its radical monopoly over personal productivity.

UNDEREQUIPMENT, OVERDEVELOPMENT AND MATURE TECHNOLOGY

THE combination of transportation and transit that constitutes traffic has provided us with an example of socially optimal per capita wattage and of the need for politically chosen limits on it. Traffic is also a model for the convergence of worldwide development goals, and a criterion by which to distinguish those countries which are lamely underequipped from those that are destructively overindustrialized.

A country can be classified as underequipped if it cannot outfit each citizen with a bicycle or provide a five-speed transmission for anyone who wants to pedal others around. It is underequipped if it cannot provide good roads for the cycle, or free public motorized transportation for those who want to travel for more than a few hours in succession. No technical, economic or ecological reason exists why

such backwardness should be tolerated anywhere in 1975. It would be a scandal if the natural mobility of a people were forced to stagnate on a pre-bicycle level against its will.

A country can be classified as overindustrialized when its social life is dominated by the transportation industry, which has come to determine its class privileges, to accentuate its time scarcity, and to tie its people more tightly to the tracks it has laid out for them.

Beyond underequipment and overindustrialization, there is a place for the world of post-industrial effectiveness, where the industrial mode of production complements other autonomous forms of production. There is a place, in other words, for a world of technological maturity. In terms of traffic, it is the world of those who have tripled the extent of their daily horizon by lifting themselves onto their bicycles. It is just as much the world marked by a variety of subsidiary motors available for the occasions when a bicycle is not enough and when an extra push will limit neither equity nor freedom. And it is, too, the world of the long voyage: a world where every place is open to every person, at his own pleasure and speed, without haste or fear, by means of vehicles that cross distances without breaking with the earth which man walked for hundreds of thousands of years on his own two feet.

Underequipment keeps people enslaved to primordial nature and limits their freedom. Overindustrialization does not admit of differences in production and political style. It imposes its technical characteristics on social relations. The

world of technological maturity permits a variety of political choices and cultures. The variety diminishes, of course, as a community allows industry to grow at the cost of autonomous production. Reasoning alone can offer no precise measure for the level of post-industrial effectiveness and technological maturity appropriate to a concrete society. It can only indicate in dimensional terms the range into which these technological characteristics must fit. It must be left to a historical community engaged in its own political process to decide when programming, space distortion, time scarcity and inequality cease to be worth its while. Reasoning can identify speed as the critical factor in traffic. It cannot set politically feasible limits.

Only when top speeds on personal carriage reflect the enlightened self-interest of a political community can they become operative. This interest cannot be expressed in a society where one class monopolizes not only transportation, but communication, medicine, education and weapons as well. It does not matter if this power is held by legal owners or by entrenched managers of an industry that is legally owned by the workers. This power must be reappropriated and submitted to the sound judgment of the common man. The reconquest of power starts with the recognition that expert knowledge blinds the secretive bureaucrat to the obvious way of dissolving the energy crisis, just as it has blinded him to recognize the obvious solution to the war in Vietnam.

There are two roads from where we are to technological maturity: one is the road of liberation

from affluence; the other is the road of liberation from dependence. Both roads have the same destination: the social restructuring of space that offers to each person the constantly renewed experience that the centre of the world is where he stands, walks and lives.

Liberation from affluence begins on the traffic islands where the rich run into one another. The well-sped are tossed from one island to the next and are offered but the company of fellow passengers en route to somewhere else. This solitude of plenty breaks down as the traffic islands gradually expand and people begin to recover their native power to move around the place where they live. Thus, the impoverished environment of the traffic island can embody the beginnings of social reconstruction, and the people who now call themselves rich will break with bondage to overefficient transport on the day they come to treasure the horizon of their traffic islands, now fully grown, and to dread frequent shipments from their homes.

Liberation from dependence starts at the other end. It breaks the constriction of village and valley and leaves behind the boredom of narrow horizons and the stifling oppression of a world closed in on itself. To expand life beyond the radius of tradition without scattering it to the winds of acceleration is a goal that any poor country could achieve within a few years, but it is a goal that will be reached only by those who reject the offer of unchecked industrial development made in the name of an ideology of indefinite energy consumption.

Liberation from the radical monopoly of industry

is possible only where people engage in a political process founded on the protection of optimal traffic. This protection, in turn, demands a recognition of those energy quanta upon whose neglect industrial society has been built. These energy quanta can carry those who consume that much, but no more, into a post-industrial age that is technologically mature.

Liberation which comes cheap to the poor will cost the rich dear, but they will pay its price once the acceleration of their transportation systems grinds traffic to a halt. A concrete analysis of traffic betrays the truth underlying the energy crisis: the impact of industrially packaged quanta of energy on the social environment tends to be degrading, exhausting and enslaving, and these effects come into play even before those which threaten the pollution of the physical environment and the extinction of the race. The crucial point at which these effects can be reversed is not, however, a matter of deduction, but of decision.

BIBLIOGRAPHY

Seminars on 'Alternatives to Acceleration in the Improvement of Traffic' and on 'The History of Thermodynamics Applied to Personal Transportation' are meeting at CIDOC in Cuernavaca during 1974 and 1975. The following list has been culled from the seminar library. Only those titles have been quoted which, besides having proved useful in past sessions of the seminar, could easily be overlooked by those who might wish to pursue the line of inquiry followed in this essay.

ALBION, R. G., *Naval and Maritime History, An Annotated Bibliography*. Mystic, The Marine Hist. Assn. Conn. 1972.

ANDERSON, Romola and Roger, *The Sailing Ship: Six Thousand Years of History*. London, Harrap, 1926.

BANKS, Arthur S., *Cross-Polity Times Series Data*. Cambridge, Mass., MIT, 1971.

BARKIN, David, 'El consumo y la vía chilena al socialismo; reflexiones en torno a la decisión automotriz'. Versión Preliminar. *Centro de Estudios Socio-Económicos*, Santiago de Chile, 1972. (Available from CIDOC Library.)

BERNSTEIN, M. T., *Steamboats on the Ganges*. Bombay, Orient Longmans, 1960.

BIVAR, A. D. H., 'The Stirrup and Its Origins'. *Oriental Art*, vol. I, 1955, pp. 61–65.

BLAISDEL, R. et al., *Sources of Information in Transportation*. Evanston, Ill., Northwestern University Press (The Transportation Center), 1964.

BOWDEN, Frank Philip, Art. on 'Friction' in the *Encyclopaedia Britannica*, vol. 9, pp. 840A-841.

BRANCH, Melville C., *Comprehensive Urban Planning: A Selected Annotated Bibliography with Related Materials*. Sage Publications, 1973. For material on transportation, cf. pp. 251–272.

BRAUDEL, Fernand, 'La Lenteur des Transports' in *Civilisation Materielle et Capitalisme, XV-XVIII Siècle*, pp. 314–329. Paris, Armand Colin, 1967.

——. 'Vicissitudes des Routes' in *La Méditerranée et le Monde Mediterranéen*, pp. 242–259. Paris, Armand Colin, 1949.

BRUNOT, Ferdinand, *Histoire de la Langue Française des Origines a nos Jours*. For references to 'transport', cf. esp. tome VI, pp. 357–360 and tome VII, pp. 201–231.

BUCHANAN, C. D., *Mixed Blessing: The Motor Car in Britain*. London, 1958.

BUFFET, B., *L'Eau Potable à travers les Ages*. Liege, 1950.

CAUNTER, C. F., *The History and Development of the Cycles, As Illustrated by the Collection of Cycles in the Science Museum*. London, 1955.

CAVAILLES, Henri, *La Route Française, son Histoire*. Paris, 1946.

CHERMAYEFF, Serge, and TZONIS, Alexander, *Shape of Community*. Penguin, 1971.

CLAXTON, E. C., 'The Future of the Bicycle in a Modern Society'. *Journal of the Royal Society of Arts*, January, 1968, pp. 114–135.

COOK, Walter L., *Bike Trails and Facilities: A Guide to Their Design, Construction and Operation*. Wheeling, W.Va., American Institute of Park Executives, 1965.

COPELAND, John, *Roads and Their Traffic, 1750–1858*. Newton Abbot, 1968.

DAVENAS, Paul, *Les Messageries Royales*. Paris, 1937.

DEFFONTAINES, P., 'Sur la Reparticion Géographique des Voitures à Deux Roues et à Quatre Roues'. *Traveaux du Premier Congrès Internacional de Folklore, Paris 1937*, p. 117 ff. Arbault, Tours, 1938.

DEISCHEL, Erwin, *Umweltbeanspruchung und Umweltschaeden durch den Verkehr in der BDR*, Munich, 1971.

DOLLFUS, C., *Historie de la Locomotion Terrestre*. Paris, 1935–36.

EKHOLM, Gordon F., 'Wheeled Toys in Mexico'. *American Antiquity*, vol. 2, 1946, pp. 222–228.

FARVAR, M. Taghi and MILTON, John, *The Careless Technology: Ecology and International Development*. Garden City, N.Y., The Natural History Press, 1972.

FORBES, R. J., 'Land Transport and Road Building, 1000–1900'. *Janus*, vol. 46, 1957, p. 100.

——. *Notes on the History of Ancient Roads and Their Construction*. Second Edition. Amsterdam, 1964.

FOSTER, George M., *Culture and Conquest: America's Spanish Heritage*. Chicago, Quadrangle Books, 1960.

FROMM, Gary, ed., *Transport Investment and Economic Development*. Washington, D.C., The Brookings Institution Transport Research Program, 1969.

FULLER, R. Buckminster, *World Resource Inventory*. Carbondale, Southern Illinois University Press, 1965. Cf. esp. vol. 4, part 4.

FULLER, Dudley D., *Theory and Practice of Lubrication for Engineers*, N.Y., Wiley, 1956.

GIEDION, Siegfried, *Mechanization Takes Command*. New York, Norton, 1969.

GINSBURG, Norton, *Atlas of Economic Development*. University of Chicago Press, 1961. Cf. esp. pp. 100–101 and pp. 60–77.

GOETZ, Wilhelm, *Verkehrswege im Dienste des Welthandels: Eine Historisch-Geographische Untersuchung*. Stuttgart, 1888.

HALDANE, J. B. S., 'On Being the Right Size' in James R. Newman, ed., *The World of Mathematics*, vol. II. New York, Simon and Schuster, 1956.

HALL, Edward T., *Hidden Dimension*. New York, Doubleday, 1969.

HANNEN, Bruce, 'Options for Energy Conservation'. Unpublished manuscript, Feb., 1973. CIDOC Library.

HASEBRŌK, Johannes, *Griechische Wirtschaftgeschichte und Gesellschaftgeschichte bis zur Perserzeit*. Tübingen, 1931.

HAUDRICOURT, André G., 'Contribution a la Géographie et a l'Ethnologie de la Voiture'. *Revue de Géographie Humaine et Ethnologie*, 1948. pp. 54–64.

HEICHELHEIM, Fritz M., *An Ancient Economic History, From the Paleolithic Age to the Migrations of the Germanic, Slavic and Arabic Nations*. 3 Volumes, Leiden, 1938.

HERENDEEN, R., Use of Input/Output Analysis to Determine the Energy Cost of Goods and Services. Mimeograph, 22 pp. Urbana, University of Illinois (Center for Advanced Computer Studies), Feb. 20, 1973.

HIRST, E., *Energy Efficiency for Passenger Transportation and for Freight Transportation*. Oak Ridge National Laboratories, 1971.

HORNELL, J., *Water Transport: Origins and Early Evolution*. Cambridge University Press, 1946.

HOSKINS, Halford, *British Routes to India*. New York, 1928.

HUNTER, Holland, *Soviet Transport Experience, Its Lessons for Other Countries*. Washington, D.C., The Brookings Institution Transport Research Program, 1968.

JOPE, E. M., 'Vehicles and Harness' in Singer, *A History of Technology*, vol. 2, p. 537. Oxford University Press, 1956.

KALMUS, Ludwig, *Weltgeschichte der Post mit besonderer Berücksichtigung des deutschen Sprachgebietes*. Vienna, 1937.

KIRKLAND, Edward, *Men, Cities and Transportation: A Study of New England History, 1820–1900*. Two volumes. Cambridge, Mass., 1948.

KOHL, Johann Georg, *Der Verkehr und die Ansiedlungen der Menschen in ihrer Abhaengigkeit von der Gestaltung der Erdoberflaeche*. Leipzig, 1841.

LANSING, John B.; MARANS, Robert W., et. al., *Car Ownership, Annual Mileage, and the Journey to Work*. Ann Arbor, Institute for Social Research, The University of Michigan, 1970. Cf. esp. pp. 137–151.
LAPIN, Howard, *Structuring the Journey to Work*. Philadelphia University Press, 1964.
LARTILLEUX, H., *Geografía de los Ferrocarriles Españoles*. M. Rivadaneyra, 1954.
LEFEBVRE des NOETTES, R., *L'Attelage et le Cheval de Selle à travers les Ages; Contribution à l'Histoire de l'Esclavage*. Paris, Picard, 1931.
——. *De la Marine Antique à la Marine Moderne: La Revolution du Gouvernail*. Paris, 1935.
LEWIS, Richard S. and SPINRAD, Bernard I., *The Energy Crisis*. Chicago, Educational Foundation for Nuclear Science, 1972.
LIEPMANN, Kate K., *The Journey to Work, Its Significance for Industrial and Community Life*. London, 1944.
LINDER, Staffan Burestam, *The Harried Leisure Class*. New York, Columbia University Press, 1971.
LISCO, Thomas E., 'The Future of Urban Transportation; Mass Transportation: Cinderella in Our Cities'. *The Public Interest*. 1970.
LOPEZ, R. S. and RAYMOND, J. W., eds., *Medieval Trade in the Mediterranean World: Illustrative Documents*. New York, Columbia University Press, 1955.
MANHEIM, Marvin L., 'Principles of Transport Systems Analysis'. *Proceedings of the Seventh Annual Meeting of the Transportation Research Forum*, 1966, pp. 9–21.
MARSH, George Perkins, *The Earth As Modified by Human Action*. Third Edition. New York, 1888.
MEYER, Balthasar H., ed., *History of Transportation in the United States before 1860*. Washington, D.C., 1917.
MEYER, John R., Art. on 'Transportation: Economic Aspects' in the *Encyclopedia of Social Sciences*, vol. 16, pp. 134–140.
MOTT, George Fox, 'Transportation in Contemporary Civilization' in *Transportation Renaissance*, vol. 345 of The Annals of the American Academy of Political and Social Science, pp. 1–5, Philadelphia, 1963.
MACKAYE, Benton, 'Townless Highways for the Motorist'. *Harper's Magazine*, Aug., 1931.
MCMURRAY, David F. E., *Aspects of Time and the Study of Activity Routines*. Thesis for the M.S. in city planning. Cambridge, Mass., MIT, 1968.
NEEDHAM, Joseph, 'Vehicles for Land Transport' in *Science and Civilization in China*, vol. 4 (Physics and Physical Technology), part II (Mechanical Engineering), pp. 243–281. Cambridge University Press, 1965.
——. 'Power Sources and Their Employment, (1) Animal Traction' in *ibid.*, pp. 303–328.
OLSSON, Gunnar, *Distance and Human Interaction: A Review Bibliography*. Philadelphia (Regional Science Research Institute, bibl. sec. 2), 1965.

OSTWALD, W., *Energetische Grundlagen der Kulturwissenschaft*. (Philosophisch-Soziologische Bücherei Bd. 16) Leipzig, 1909.
OTTLEY, George, *A Bibliography of British Railway History*. London, Allen and Unwin, 1965.
OWEN, Wolford, *Strategy for Mobility*. Washington, D.C., Brookings Institution, 1964.
PERRATON, Jean K., 'Planning for the Cyclist in Urban Areas'. *The Town Planning Review*, vol. 39, no. 2, July, 1968, pp. 149–162.
PLATT, John, 'Hierarchical Restructuring'. *Bulletin of Atomic Scientists*, Nov., 1970.
POLANYI, Karl. ed., *Trade and Market in Early Empires*. Glencoe, Ill., The Free Press, 1957.
ROBBINS, Michael, *The Railway Age*. London, Routledge and Kegan Paul. Penguin, 1964.
RUSSEAU, Pierre, *Histoire des Transports*. Paris, Artheme Fayard, 1961.
SAUER, Carl O., *Agricultural Origins and Dispersal*. Bowman Memorial Lectures, Series Two. New York, 1952.
SAUVY, Alfred, *Les Quatre Roues de la Fortune: Essai sur l'Automobile*. Paris, 1968.
SCHNORE, Leo F., Art. on 'Transportation, Commutation' in the *Encyclopedia of Social Sciences*, vol. 16, pp. 140–144.
SHERRINGTON, Charles E. R., *A Hundred Years of Inland Transportation, 1830–1933*. London, 1934. Kelly reprint, 1969.
SMERK, George M., *Readings in Urban Transportation*. Bloomington, Indiana University Press, 1968.
SMITH, Joel. Art. on 'Transportation: Social Aspects' in the *Encyclopedia of Social Sciences*, vol. 16, pp. 129–134.
SMITH, William, *The History of the Post Office in British North America, 1639–1870*. Cambridge University Press, 1920.
SPENGLER, Joseph, 'On the Progress of Quantification in Economics' in Harry Woolf, ed., *A History of the Meaning of Measurement in the Natural and Social Sciences*, pp. 128–146. New York, Bobbs Merrill, 1961.
STONE, Tabor R., *Beyond the Automobile: Reshaping the Transportation Environment*. Englewood Cliffs, N.J., Prentice Hall, 1971.
STRUBE ERDMANN, Leon, *Vialidad Imperial de los Incas*. Universidad de Córdoba, Argentina, 1963.
SUNDQUIST, James L., 'A Policy for Urban Growth: Where Shall They Live?' *The Public Interest*. No. 18, Winter 1970.
STUTZ, Frederick P., *Research on Intra-Urban Social Travel: Introduction and Bibliography; Exchange Bibliography No. 173*. Monticello, Mich., Council of Planning Librarians, Feb., 1971.
TAYLOR, George, *The Transportation Revolution*. New York, Harper & Row, 1951.
TERRAZAS DE LA PEÑA, Eduardo, 'Necesidad de un Incremento en la Intensidad del Uso del Espacio'. Paper presented at a regional meeting on urban development policies, Mexico City, July, 1972. CIDOC Library.

Transportation Renaissance, Vol. 345 of The Annals of the American Academy of Political and Social Science. Philadelphia, 1963.

TURNER, John F. C., 'Housing for People or Housing by People'? Mimeograph, 10 pp. Cambridge, Mass., MIT, 1970.

WESTERGAARD, John, 'Journey to Work in London Region'. *TPR*, April, 1957.

WHEELER, James O., *Research on the Journey to Work: Introduction and Bibliography; Exchange Bibliography No. 65*. Monticello, Mich., Council of Planning Librarians, January, 1969.

WHITE, Lynn, 'Tibet, India and Malaya as Sources of Western Medieval Technology'. *American Historical Review*, vol. 65, 1960, pp. 515–526.

——. 'The Agricultural Revolution of the Early Middle Ages' in *Medieval Technology and Social Change*. Oxford University Press, 1969, pp. 39–78.

WHITE, Leslie, *The Science of Culture: Energy and the Evolution of Culture*. New York, Grove Press, 1949. cf. esp. pp. 363–393.

WILSON, S. S., 'Bicycle Technology'. *Scientific American*, March, 1973, pp. 81–91.

WILSON, George W., et. al., *The Impact of Highway Investment on Development*. Washington, D.C., The Brookings Institution Transport Research Program, 1966.

YURICK, Sol, 'The Political Economy of Junk'. *Monthly Review*, vol. 22, no. 7, Dec., 1970, pp. 22–37.