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Resource-Conserving Cities

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RESOURCE-CONSERVING CITIES

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## FOREWORD

This working paper is quite obviously the beginning of a book. A number of independent lines of investigation started to converge upon a theory of human development for the post-industrial age. I am still struggling to find appropriate language with which to present ideas that are not yet in the mainstream. My object is to make them so clear and simple that they will seem as obvious and true to the reader as they are to me.

Materials to be added will present the following arguments:

1. Metropolises have, in a few instances, become economic "engines" that drag a whole region into a modernizing, welfare-improving era, and principles for designing such an engine can be inferred from successes to date.
2. A new complex of technologies can be presented which by the turn of the century should allow rapid urban growth that consumes only 5-10% of the natural resource inputs per capita of Western countries today but allows at least as much opportunity for cultural activity on the part of the residents.
3. Urbanization also leads to political development within a society, so that after an initial difficult period governments become increasingly stable, representative, participatory, and effective in implementing reforms, mainly because a variety of sites is provided that are conveniently placed for expanding the range of bargaining and negotiation.
4. The directions for lowest cost growth of urbanism can be outlined: cities will become discontinuous on land, spill out over nearby water surfaces, create special colonies for their citizens in the hearts of other great cities, and provide bases of operation for cosmopolitan professional groups as well as transnational corporations, thereby loosening the controls over persons now jealously held by nation-states.

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## RESOURCE-CONSERVING CITIES

### Introduction

The ideas behind these studies upon future urbanization have been growing for a long time but they came together while I was a member of a team of planners working with the Venezuelans in 1965. Five years earlier the Venezuelan government had decided to build a new port city on the Orinoco River with the specific intent of maximizing the social product obtainable from the extraordinarily rich combination of resources in the region.

In many ways this was an ideal assignment for the American planners convened by the Joint Center for Urban Studies of Harvard and M.I.T., because the hypocrisy and the autism normally associated with "foreign aid" was not present; the Venezuelans had committed a large part of their oil royalties for the implementation of the development plan and were willing to pay for the best advice available. This was not an exercise in Utopianism but a practical effort to accomplish as much as possible for the nation as a whole within a short span of years.

Gradually the vision of a new city of more than a quarter of a million people was built up out of the cross-currents of proposals, critiques and experiments in the field. Meanwhile people were arriving at a rate of a thousand a month to occupy the site of our new city; a smaller, variable number left disappointed. The outline plan may not have been optimal, but it was close to the best that planners from developed and developing countries, when yoked together, knew how to do. Nevertheless, as I reviewed the prospects, this was a kind of plan for cities that should never be done again on this

scale or any larger one. Although designed to develop and export natural resources, this city was too wasteful of those resources to be repeated elsewhere. No combination of deposits of highly marketable minerals, waterpower potential and forests is every likely to be found so close together again on this earth. Most of us from the United States had gone into the project hoping to learn in these favorable conditions how to plan and design cities that would develop societies and regions. I came to the conclusion that the approach taken was satisfactory for this instance, but I could not, as a responsible planner, transfer what I had learned to other places in the world. It was a dismal conclusion, and set me to speculating how a developmental metropolis should be planned when, as would be universally true in the future, the society has limited access to natural resources.

Thus I found myself working feverishly at night in a small Caracas hotel room spelling out strategies for conserving water, energy, materials, capital and human time, while during the day at the office my calculations for the Guayana region of the 1970's showed that they could be spent almost profligately. I knew that my contemporaries working on urban development in India, Pakistan, Nigeria, Turkey, Thailand and elsewhere were reaching approximately the same official recommendations as I about the resource mix because we were all using world prices. However, if those plans succeeded to some extent in developing these countries, severe scarcities would appear and our proposals could not be completed. My knowledge of geology and technology was sufficient to recognize that the anticipated urban population was so large its needs could exceed prospective supplies by two to five fold. I felt a bit uncomfortable as a professional who presumed he was doing good as well as he knew how but still recognized that he was

reinforcing a trend likely to resurrect the Malthusian spectre, should the lessons he was teaching by example ever actually be put to use.

The foregoing arguments were sufficient to explain my concerns to others, but were still too superficial to suggest solutions. One needed also a conceptual framework which indicated how and where the assembly of new facts and ideas might shift the strategies for development. That framework did not exist in any single discipline, but was required to range over a number of established fields and encompass subjects that had still not been devolved from the mother discipline--philosophy.

General systems theory produces many contexts for the comprehension of urbanism. Therefore it is a fertile source of insights and hypotheses. Such tentative propositions should be tested first against the existing body of knowledge; if they still stand they deserve to be subjected to experiment. This is different from the "systems analysis" approach common to a number of applied sciences, because the latter utilizes a single framework closely tuned to the experience of its promoter. Systems analysis of urban growth all too often leads me into impasses from which no amount of reshuffling of control variables can extricate me. The search for formal analogies and for supra-system that characterizes the general systems approach stimulates the imagination with its panoramic overviews and thus introduces potential substitutes for scarce inputs. Presumably, it works because, as John Ziman says in his book Public Knowledge (1968), scholars must arrive at a consensus in organizing a body of phenomena; the social process of achieving agreement regarding an efficient and parsimonious representation of knowledge results in bodies of theory that have strong equivalences to each other, particularly when scientists carry on their discourse with the same natural language (e.g., English, French or German).



I would be incapable of thinking of urbanism as an outgrowth of living systems had it not been for associations with James G. Miller, Ralph Gerard, Anatol Rapoport, Kenneth Boulding and the circle around them starting ten years earlier. They patiently (and on some occasions impatiently) disentangled nested levels of organization and formulated a number of cross-level analogs. Linguistics could be mapped upon genetics, psychology upon economics, and the discrepancies separating one from the other provided stimuli for interesting new hypotheses. As a consequence, it became possible for a few of us to jump to the realization that the city may be usefully considered to be a self-created environment that determines the continuation of the evolution of the human species.

Biological arguments came naturally to me at that time in Venezuela because I had brought along Ernst Mayr's latest great work, Animal Species and Evolution, for reading during siesta periods. The return to first principles demanded by the concept of "resource-conserving cities" required that one start with the most primitive specifications of human needs when aggregated in large numbers.

Biologists long ago pointed out that the fitness to survive and reproduce in humans is now determined more by cultural factors than by the challenges presented to individuals by the natural environment. Fitness now depends neither upon quickness of wit nor upon alertness to threat. Brawn is equally obsolete. Cities have encapsulated a variety of significant cultural forces, causing them to become institutionalized so that most personal crises are succored by an organization of specialists. With the new differentiation of peoples into social classes and occupational groups, cities are introducing new capabilities for the collective control of the total environment of man. Once these conditions are recognized, we can proceed to ask what selective pressures exist that are traceable to the kinds of competition

maintained in the urban environment. What are the genetic and somatic characteristics of the generations that will be forced to get along in urban environments while consuming much less of the familiar natural resources per head than city dwellers at present?

Some of the facts cause apprehension. Note, for example, the larger implications of the principle stating that once a species establishes itself in a new environment its biomass increases to a level close to the limits set by the energy chain. This can be disastrous for a population that is rapidly depleting both its fossil and fissile fuels. The generalization causes us to measure the biomass of man, comparing it with what is known about other species, only to discover that Homo sapiens appears to be second already among all species, but the first--a combination of some 231 breeds of cattle--is a species that is now fully domesticated by man. Most of the other plentiful species, plant and animal, have also been domesticated. Moreover present trends suggest that humans will shortly reach the top in the protoplasm contest, and most of the human biomass will converge upon cities for life supports!

As cities have grown and developed, they have streamlined the food web so that an increasing proportion of the original calories of energy fixed from sunlight is used in the metabolism of the city. We are forced to view our cities as a congregation of predators (dogs and cats as well as humans) that kill at a distance. Such a population may exhibit acute strains when its numbers press against the limits of the nutritional resources upon which its members live. Surprisingly, there is no scientific literature as yet which takes up the synthesis of balanced urban ecosystems, even though millions of dollars have been expended in researching closed systems for spaceships. Fortunately, one can find bits and pieces, even some sub-assemblies,

in abundance in the technological literature so that several quite different systems for the transfer of energy and recycling of protoplasmic building materials can be proposed that appear to be both technically and economically feasible. (See my "Resource-Conserving Urbanism: Progress and Potentials," March 1970, Center for Planning and Development Research, #112.)

The living system, as understood by biologists, has directions for development or evolution but not goals. It is influenced in the directions it takes by forces and structures in the environment, but it cannot make decisions that are subsequently implemented. The living systems theorist plays the role of external observer-analyst, endeavoring to discover an economical means for presenting the range of possibilities that actually exists for the evolution of man and the likelihood of each distinctly different outcome. As long as he employs the discipline of biology, or of "black box" psychology, he remains an outsider to the system, similar in many respects to the traffic analyst interpreting the movements of impersonal automobiles and trucks through a maze of freeways, arterial roads and parking places. Both are able to provide warnings based upon observed trends, but observational science by itself offers no strategy for avoiding catastrophe. In fairness, however, it should be said that it occasionally identifies points in the system where a small intervention can have amplified effects of a largely predictable kind. Nevertheless, for decision, or calculated avoidance of inferior alternatives, we must start from inside the living system. We must look at the individual in the population, his means for affecting his immediate environment by interacting within a group, and by his participation in institutions.

This other body of systems thinking applicable to cities starts from a belief that we can gain some control over our collective destiny. History shows that there have been ways of evading the catastrophic losses in the welfare of individuals, as experienced in famines, epidemics and breakdowns in social order, which may be quite independent of biological forces influencing the survival and maintenance of populations. Strategies for planned action can advance the middle run welfare of individuals and their organizations.

My behavioral model of the typical autonomous urbanite presumes he bargains with organizations, offering a portion of his own time, effort, and attention in order to obtain goods and services. He walks around in a synthetic environment viewing the living system from the interior as a "participant observer" who is altruistic on only a few occasions, follows along in the rut of tradition most of the time, while calculating self-interest on a number of occasions.

An individual living in a metropolis must make repeated decisions about what niche is best for himself. I have little quarrel with this elementary assertion. However, in order to make satisfactory decisions for himself that individual needs to have a relatively stable environment, one that holds a large share of the less important factors constant. Nevertheless, it should not be dead or static, but offer a limited variety of opportunities for self-improvement at low risk to himself. A review of the ways in which urban dwellers spend their time suggests that they allocate 10-30% to restoring order in their immediate environment. This is time spent in personal grooming and the maintenance aspects of housekeeping. However, an even great amount of attention is devoted to making choices for others--family, friends, peer groups, face-to-face associations, firms, offices and others. In all of these

a kind of micro-order must be created by cooperation. There the individual needs to appear altruistic or conforming in order to gain the needed cooperation of others.

From positive and rewarding experience at the household, neighborhood, and work-place scale, the mind leaps easily to proposals for controlling the larger ecosystem. Almost certainly there are ways of defeating the stringent effects of the aforementioned biological principles, or at least ways for deferring or mitigating their impact. This hope seems most possible in the modern metropolis, because the dependence upon the chanciness of weather and disease has been greatly reduced by constructing an artifact surround.

The urban system, from the insider's vantage point, is no larger than the microcosm which includes the detectable effects of a choice. External effects tend to disappear the further one moves away from the locus of that choice. Normally a branching chain of transactions must be reviewed in prospect, and the net consequences calculated. The problems of project appraisal are well known to economists, because they have specialized in formulating techniques for optimization. These methods fail frequently in the metropolis, however, because unprecedented chain reactions can occur very easily in a densely packed space. Experiences with unanticipated reinforcement or damping out of secondary effects of a choice cause the decider to ask for much more information about his immediate environment. Of course, he wants this information at very little cost to himself. Control over the essential features of the urban environment depends upon a flow of relevant information to a population of decision makers acting relatively independently of each other.

Increasingly, therefore, the urban environment must be designed to produce reliable signals for the individual decision-makers. It also needs to record data on its flow of transactions for the managers of the environment to assess. They, too, must improve their strategies for conservation and utilization.

An inside view of urban control systems draws upon law and tradition for its source of order. Physical property provides another set of phenomena one expects to remain constant for the sizable part of a human lifetime. These factors provide the setting for the metabolic activity in the city, the system maintenance features that call into play a multiplicity of feedback loops. The modern city has evolved many mechanisms for reporting deviations from the steady state, and urban institutions have set up alarm systems for detecting when the shift may become destructive. Action mechanisms for restoring the status quo, or making an adjustment upon it, have often been prepared in advance--the contingency plans. The response times range from a matter of minutes in the market place to years in the case of some political and social reactions.

We need growth models for the metropolis that go beyond the shifts in structural proportions and spatial relationships as size increases. We need models for enhancing capabilities--learning by planning as well as learning by looking--of metropolitan decision systems. How can a Tokyo-scale development rate be installed in other metropolitan areas? How can this record achievement be improved upon as it is transmitted to Taipei, Seoul, Singapore and elsewhere? Tokyo comes as close as anything yet invented to the leviathan that reports continuously about itself to itself concerning how it is doing and what may happen in a few days or months. Tokyo has less competence in coping with the middle to long run; for those decisions it has waited for

the pioneering to be done in America or Western Europe. The modes of metropolitan government are obviously relevant, but so is the operation of headquarters offices of trans-regional and trans-national corporations, because the true nature of the competition between urban regions shows up in the data they assemble. Rapid improvements in security and welfare are possible when the mobile capital and skills can be attracted away from the less effective urban environments, i.e., another kind of "predation at a distance."

Therefore, I find myself oscillating from the philosophical, detached observer's view of living systems to the internal, advice-oriented image of the way a city should work on the basis of what is known. The first allows me to gauge what new challenges cities may have to face in the future as a result of increasing size, age, resource depletion, or new knowledge available to all. The second allows me to find strategies and define policies or institutions that should be able to cope with the prospective challenges.

The principal difficulty is that of communicating to other investigators who are intellectually anchored in one or the other viewpoint. The rules for disciplined reporting are violated. However, I shall commit these sins as long as productive insights emerge.

## I. The Metropolis as Resource Transformer

The modern metropolis converts resources into something else. James Rouse, the developer of the new town of Columbia midway between Washington and Baltimore, captured a bit of this when he was heard saying to his planners, architects and engineers, "I want an environment that grows people." It was their job to specify the environment and his to acquire the land, find the financial backing and tend to the marketing. He had caught a glimmering of the city of the future and he also seems to be well on the way to making his version of it pay dividends. The new function of cities for some generations to come is to "develop human resources." They must gather in commodities won from the earth's crust and convert them into civilized, whole people able to make their way in the world. Nor should waste, rubble or pollution be allowed to accumulate to the point that they stifle the development of the new generations.

Somehow the resource issues that have raised a furor in recent years have missed the point. Repeatedly the emphasis has been placed upon preventing water and air pollution, saving the seashores and redwood forests and preventing the extinction of species of wildlife. Halting the waste of fossil fuels and other minerals has been a concern in many regions. But to what end? The good life? That is an answer used by those who have been converted to the religion of conservation but it falls upon deaf ears among the unbelievers. The latter see only a ritual, or perhaps evidence of a conspiracy of the elite to remake the environment according to their private values. They hear repetitious preaching



on modern sins. The argument must be spelled out in more meaningful and constructive terms if most people are to be persuaded.

Man in all his numbers, highly interdependent yet continually seeking novelty, is a place to start as well as to end. A homocentric bias seems to be the most appropriate filter through which the workings of a city can be seen and understood. Man as a species is the powerful, free-ranging predator at the top of a carefully nurtured web of interdependencies between living populations. The other species in the biosphere are there either to feed man or to please him; if they do not have those functions they are likely to become nuisances some day--a condition that is likely to result in depopulation of the offending species and possibly its eventual local extinction.

This property of dominance is all-important to the study of cities. If man ceases to be dominant in nature, cities must be abandoned because they would no longer obtain food and offer sanctuary. Lions, sharks, grizzly bears and eagles are most likely to come back. Eventually the physical city would crumble away leaving gaunt skeletons of concrete and steel standing over a mound in the plane. Thus the fate of the city is bound up indissolubly with man's power to control Nature, but the dimensions of cities are still out of control to the extent that human population is out of control. All arguments proposing complete submission to the natural laws affecting other mammals are romantic fantasy or blind dogma. They ignore the natural laws affecting the accumulation of collective knowledge.

Why city and not nation? For the past century, and in some places much longer, nations assumed the responsibility for constructing modern environments. They intervened in the production schemes that drew directly upon natural resources, insisting upon a more orderly exploitation. Nations

long ago began to undertake programs in the conservation of human resources particularly by means of epidemic prevention and other public health measures. Also, the further development of human resources was expedited through state-sponsored educational systems and supported by integration of transport systems. However, the action taken has almost always been production-oriented. It has rarely been aimed at making the consumption process efficient. Consumption has been interfered with only in times of great emergency when supplies were critically scarce and rationing was necessary. Then people could survive, but often performed less well because the substitutes offered for the scarce commodities were for the most part inadequate.

No advance planning for the conservation of the scarcest resources at the point of consumption had worked well. The reason that planning of consumption has rarely been carried out is that there are many more consumers than producers to influence, and much more information is required for reaching decisions about consumption that approach the optimum. Most of the consumer's information must be obtained and disseminated in the same locale rather than trickling through layers of national bureaucracy. These more complex tasks of information distribution are left for urban communities and urban institutions.

#### What is a Resource?

Everyone has a generalized idea of what resources are and the ways in which they may be identified. Each of us puts minerals and forests and waterfalls into this category almost automatically. Any person living near the sea will add fisheries to the list. Those who are in food enterprises recognize the significance of the living soil--micro-organisms, worms, moisture and

and humus--as a basic resource. More recently the highly unusual environments, the kinds that excite wonder in man, have been marked as a scenic resource. The common meaning of the word is based upon these agreements between people with quite different personal experiences.

Let us examine further the implications of the idea of a resource. It starts with some unusual quality found in a locale that makes it different from the normal physical environment. This difference is great enough to assign a functional name to the type of locale. There are ore bodies, oil pools, pine woods, fishing banks, fruit belts, waterfalls, and natural harbors, to name a few. Each of these is a resource, however, only when the information about it can be combined with experience with a technology--a body of human knowledge that can be passed along from one place to another and one generation to the next. Only then can the resource produce something of value to man. The knowledge embodied in a technology is general enough to be diffusible across cultural boundaries; it can also evolve or develop over time, accumulating small scale improvements as it is applied. Normally a technology is made up of a sequence of operations or processes that can be spelled out as a series of directions or recipes for what should be done with one or more resources in order to accomplish the conversion to a desired commodity or service.

The knowledge component of resource use has been increasing in quantity and significance over time. It is recorded in images--diagrams, blueprints, laboratory analyses, mathematical equations, sets of specifications, technical terminology, etc. The resource has real value only if the effort invested in its use is more than compensated for by the returns to people. Most of the so-called natural resources in the world are not worth the expense involved in extracting or making use of them, and are

therefore relegated to the submarginal class. They become a true resource only when the scarcity of the primary commodities or services produced from such resources has increased, and price rises have occurred, or when a significant improvement in technological efficiency has been established. Advances in applied science have been more effective recently in creating resources worthy of development than has the rise in prices brought on by the exhaustion of deposits of richer concentration.

When thinking about resources is grounded in this information-based formulation, rather than upon the depletion-oriented doctrines propagated before World War II, most of the mistakes in future-oriented public policy can be easily avoided. According to the teaching of a generation ago, our fathers could look forward to a day when resources essential to civilization would be universally depleted; this would be a time when their great great grandchildren were doomed to regress to a way of life sustained only by the renewable resources of soils, vegetation, and waterpower. Feature stories in magazines and newspapers and university lectures on conservation dwelt upon the hard times in the future brought about by the accelerated exhaustion and waste of our richest resources. These early projections were inadequate because they did not consider the effects of the steady growth of knowledge about technology.

The acquisition, storage, and transmission of knowledge are all uniquely human activities. Some individuals have greater aptitude for this work than others, but almost everyone can improve his mastery of such knowledge by the expenditure of time and attention. Thus, as natural resources are depleted, the knowledge about substitutes and alternatives that specific people possess, or can quickly obtain, may be drawn upon to prevent deprivation in the population as a whole. As far as society is concerned the possessors

of knowledge are a resource, as valuable and dependable as any options on a new discovery of oil or the mapping of a new fishery.

These recent insights are revelations; they greatly broaden the development strategy for a modern society. The planning horizon was once limited by the expected depletion time of energy sources, but now it can be extended by building up knowledge of substitutes that are more plentiful, just as nuclear fuels can replace coal and fuel oil by advancing the technology of nuclear reactors. Having dispensed with the misconceptions of the extreme pessimists, we should not make the mistake of extreme optimism. Shortly after it had been demonstrated that nuclear energy was feasible, and the physical constants of uranium and thorium suggested that the prospective supply was hundreds, if not thousands, of times greater than the prospective fossil fuel supply, some scholars wanted to set up projects to discover what human life would be like "if energy was as free as the air we breathe." When technologists objected, saying that the transport of energy was already more expensive than its production in a large power plant, and no breakthroughs were in sight for the transport of electrical energy or any other form (although steady improvements in efficiency were attainable for at least a generation ahead), the scholars argued that additional knowledge would overcome all barriers. But knowledge about the physical environment is not magic--it uncovers new limitations of man along with new alternatives, so that substitutes for some of the natural resources will be even more roundabout and expensive than projected with the present state of knowledge. In biology unsuspected poisons and constraints upon development are discovered more frequently than new capabilities, so we need to be ever more clever in organizing social institutions in order to evade known dangers. Thus knowledge does not solve resource problems, it only tells us what policies

can be adopted which would minimize the risks for humans attributable to scarcity in the environment. We now must look forward to a more distant time when returns from the addition of knowledge have begun to decline. Knowing when that happens will require a great deal more systematization and measurement than has been achieved until now, but it does provide an opening for humanistic rather than mechanistic solutions.

#### The Common End of Natural Resources

Almost all the valuable natural resources are now found in inconvenient places. This is not attributable to the perversity of Nature but merely due to the fact that the most accessible resources are consumed first. If they have not been exhausted they are firmly and continuously committed to established social purposes, so they are not available for new projects. Not infrequently wars have been fought over the accessible resources, and more often yet they have been spent in the prosecution of wars. Thus the prospectors for new reserves are forced to range ever more widely and the cost of exploration rises continuously. Before satisfactory finds can be achieved, we are forced to dig deeper and carry the output further than at any time earlier.

At the same time we find a declining number of people employed at the point of primary production. One way of putting this point is that the efficiency of the labor of farmers, lumbermen, fishermen, miners, and petroleum field operators is increasing at a much more rapid rate than is experienced elsewhere in the society. Extrapolations show that perhaps five percent of the people are actually needed for basic production at the site, and an equal number will be involved in collecting, preprocessing and shipping. About ten percent will work at junctions and trans-shipment points that undertake the first stages of manufacturing and distribute services to the hinterland.

The eighty percent others will spend most of their time in metropolitan areas where their effort is expended in intensive, competitive consumption. Such a pattern is anticipated for a North America two decades hence, even though it is still exporting net some surplus agricultural products, wood products and coal to less well endowed countries of the world.

The fate of the natural resources, once they have been removed from the original site, is quite readily traced. The first step must refine the crude product; therefore we see grain dried and winnowed, trees are trimmed and debarked, petroleum is de-emulsified, gas is desulfurized, and ores are milled at sites not too far removed from the original site. The graded and standardized products are then moved on to processors at crossroads, many of which have not become urban centers but have remained mill towns and factory settlements. There a wide variety of basic commodities are produced--the grain reappears as flour and middlings, the trees as paper and board, the petroleum as a hundred different refinery products, each of them held to strict specifications, the gas is transformed to electric power or petrochemicals, and the ores are moved on as ingots and shapes of metal. The ultimate destination for eighty percent or more of the tonnage these commodities is a metropolitan area (Table One) where the complex, market-oriented manufacturing is carried out in as many as a dozen successive steps. The inorganic transformation of mineral resources has now reached a physical volume twenty to thirty times as great as that observed for formerly living materials, such as crops, animal products, and wood.

Curiously, most human resources in the countryside flow along the same routes as the other natural resources. The energetic and intelligent youths acquire some kind of basic education in the village schools, which is extended to secondary education in the crossroads settlements. Then they flock into the

metropolitan areas in search of steady jobs and an opportunity to excel in the professions. This is a very different group from the distress flow of preceding generations that was decanted into the slums of the cities when mechanization took command in the countryside. The human resources are transformed by modern training programs and institutions of higher education into highly disciplined specialist members of large scale organizations.

After that the flow of both products and people tends to redistribute through the network of main line corridors connecting the various metropolises. The cities carry on trade with each other at a high rate, and again people follow the goods. What moves between them are items like trademarked foods, finished furniture, branded lubricating oil, molded plastic housewares, vehicles, and technical personnel.

Then, a few months or years later, poof! the usefulness of the products runs out and they have become only so much scrap. A bit of salvage may be possible, so that the materials go through another cycle of refining, fabrication, and distribution, but even then the end is ultimately the same. Nothing remains but some polluted water, some solid waste, carbon dioxide, a small amount of the more noxious gases, and a quantity of heat that escapes the built-up areas mostly as low grade infrared radiation because the metropolis itself is maintained as a "warm body" with a temperature several degrees higher than its immediate environment. The material balances and the energy accounts for the urban system are thereby settled.

Much the same thing happens to people. Their experience and skills are drawn upon, replicated where valuable, packaged as services, sold or distributed up to the stage of market saturation, and rather quickly replaced by a more popular successor. Thus many of the actors on the metropolitan scene



require retraining (salvage?) so as to be fitted to new posts. The metropolis uses up human resources as implacably as it consumes the classic natural resources. It remakes humans into actors suited to its own operational needs, and wears them down to a shadow of their former selves before turning them out to pasture with a pension.

Thus the odyssey of each of the resources is completed; they are all consumed by the same furnaces at the end of the journey. Somehow all metropolises, taken as an aggregate, have created steadily over the past two centuries a "resource shed" that operates something like a watershed or a milk shed. Resources, once they are removed from their original resting place, gravitate to centers where their deliberately, controlled destruction has greatest value. The data in Table One suggest that, on a tonnage basis at least, the flows of water are most readily diverted, and that lower grade construction materials make up a very substantial set of inputs.

TABLE ONE

NET CONSUMPTION OF NATURAL RESOURCES IN METROPOLITAN AREAS: 1970  
(per million residents)

<u>Mineral</u>	<u>United States</u> <sup>1</sup>	<u>India</u> <sup>2</sup>
Water <sup>3</sup>	1,800,000,000 metric tons/yr. (10% domestic; 35% industrial, 55% cooling)	180,000,000 metric tons/yr. (30% domestic)
Fuel <sup>4</sup>	8,000,000 (30% coal, 40% oil, 30% gas)	400,000 (80% coal, 20% oil)
Sand, Gravel and Stone	8,000,000 (60% sand and gravel, 40% stone)	1,000,000 <sup>5</sup>
Clay, Lime, Cement		
Gypsum, Salt, etc.	1,600,000	300,000 <sup>6</sup>
Iron Ore, and Ferro- Alloy Ores	800,000	200,000
Non-Ferrous Ores and Metals	100,000	10,000
<u>Renewable Organic</u>		
Wood, Paper, and Natural Fibers	400,000	30,000 <sup>7</sup>
Foodstuffs, Staples <sup>8</sup>	150,000 (50% cereals, 30% sugar)	200,000
Foodstuffs, Perishables <sup>9</sup>	600,000 (25% dairy, 25% poultry, 20% veg.)	100,000

1. The Standard Metropolitan Statistical Area (SMSA) based upon county lines and transport routes as of 1960 is becoming steadily more obsolete, so it is assumed here that 70% of the U.S. population will be living in urban areas in 1970 even though it was only 59% for the SMSA's recorded in 1960, and 62% was projected for 1970. (U.S. Statistical Abstracts, 1970).
2. After reviewing population estimates and apparent urban growth, the urban population of India was set at 120,000,000 persons for 1970.
3. This assumes that water use in an industrial nation is somewhat greater than in non-urban areas. The total for non-irrigation uses in the United States is 2,300 tons metric per year per capita. Indian domestic use is set at 25 gallons per capita per day, since reports from various cities range 22-30 gallons per day. Perhaps 30% more than that is filtered and treated, the difference being lost in leakage. Industrial water appears to demand comparable volumes of water, on the basis of very scattered reports.

4. Railroads are a heavy user of coal in India, so only 60% of the total fuel consumption was assigned to urban users, but 90% of all U.S. fuel was assigned to these consumers.
5. No figures available; this level of consumption was deduced from the amount of cement used and the scale of flood control projects designed to protect urban areas.
6. Figures not available; these numbers were deduced from the amount of pukka housing and facilities installed (cement and brick) while allowing one kilogram of salt per capita per year. Sulfur is known to be very scarce.
7. Assumes that only half of the timber products get to the city, but about 70% of the paper and board are used there. Fibers have small volume.
8. Adjusted upward from the estimated consumption so as to allow for spoilage. FAO and WHO sources.
9. About 20% more is re-exported to surrounding non-urban areas.

The solid stuff transplanted to an urban settlement becomes an indigestible waste; it is best used to fill low places in and about the city, especially to extend shorelines. However after a generation or two the detritus and rubble accumulate onsite so that the city raises its average ground level above the surrounding plain several feet each century. Long-lived ancient cities left tells that had been raised more than fifty feet above the desert, but much of that material--dressed stone, sun-dried brick and ordinary clay-based stucco--was employed for defense purposes rather than ordinary living. Nowadays however, most major defense installations have been moved out to the empty, interstitial areas. The modern metropolis, if abandoned, would very likely not be seen as a mound of rubble but a jungle of girders, reinforced slabs, and forest that was undermined by elaborate grids of wire and pipe, much of it connecting up catacombs made up of sub-basements and storm drains. The most time-resistant material below the surface is the enamelware, particularly the toilet equipment. The trend thus far, however, is pointed away

from any abandonment of cities but moves in the direction of increasing scale of urban settlement. Momentous forces have been released by the development of science and technology in the metropolis, and they are enabling the metropolis to become still more influential and populous.

#### The Product of City Life

The quantitative aspects of the analysis up to this point has an almost traditional bias since it has been concerned more with what goes into a city rather than what comes out. We have characterized the species, Urbs ordinarius, var magnus by what it eats and occupies rather than by what it builds and contributes. The picture of the metropolis that results is that of a self-repairing, homeostatic social reactor that can, when necessary, reach out into its hinterland for needed natural and human resources. Such a metropolis may, on some occasions, harbor some aggressive units which acquire goods by coercion, but usually its concerted pressures on the surrounding territory are felt quite indirectly, as when it bids up prices or revises the system of taxation.

The varieties of the human organizations that preferentially grow up in the large city have yet to be introduced; social reactors produce the opportunities that stimulate the appearance of new autonomous units with unprecedented capabilities. In the very long run, such new organizational growth, for example, the IBM's and Social Security Administrations, and the university faculties, comprise the principal surviving output of urbanization, and several different kinds of arguments will be introduced to illuminate the truly revolutionary implications.

The idea of social reactors is worth delving into further. Engines are localized reactors that exploit energy resources in carefully constructed equipment so as to achieve a directed force. A metropolis, like an engine,

stimulates a local gain in entropy--the quotient of energy expenditure over a temperature and the precise index of disorder at a sub-microscopic level--as it metabolizes. A metropolis may also produce new knowledge along with some new organizations to conserve and utilize this added knowledge. Thus, when analyzed with the aid of information theory, some small cells of even more concentrated order are formed at the same time that much larger amounts of microscopic disorder are produced. This approach to the concept **suggests some methods of measurement of metropolitan output** that have not yet been applied in practice--the degree to which predictable events occur as compared to mistakes and surprises that are recorded instead. When the routine interactions proceed with reduced deviation or detectable error, then it is possible to build and superimpose upon that base a variety of innovating and more effective mechanisms. The parallel in the metropolis would be firms, agencies, cooperatives, professional associations, cultural ensembles, sports teams, life styles, and similar epiphenomena that can stimulate interactions between their own members which are neither frustrating or confusing to the participants.

It should be emphasized that new human organization will not necessarily grow out of a smooth flow of regularized transactions. Consider for example, cities devoted to codified ritual, such as Mecca, Banaras, or the Vatican. Creative deviation can occur there, but it is normally ruled to be heresy, and the heretics in such religions are treated harshly. At a very minimum they are expected to do penance, which can be either self-flagellation--a physical preventive behavior that acts against the implementation of a worthwhile deviation--or even more rigorous and time-consuming rituals which accomplish the same end. In each of these cities the behavior of

the pilgrim outside of the holy places is carefully prescribed, so that the creative person is inhibited in the market place and in cultural activities. Governmental responsibilities are also put aside. Manufacturing activities of almost all kinds are deemed to be frivolous, so they are rarely undertaken. Thus it is not surprising that these cities have not sparked economic development in their immediate regions. They have used the accumulation of residents and visitors merely to spin the wheels of ritual. Economic and sociocultural progress are barely noticeable, and even then seem to be traceable to inadvertent spinoffs from the circulation of pilgrims over vast distances. The metropolis must either have a laissez-faire milieu as in nineteenth century London or an aggressively open and comparatively rewarding social environment such as is found in such developmental cities as Tokyo, Los Angeles, and Sao Paulo if it is to produce units with a higher degree of order.

Another company of investigators have arrived at the same insight when following their interests in the evolution of man. Geneticists, anthropologists, and philosophers such as Haldane, Julian Huxley, Linton, Waddington, and their successors<sup>1</sup> are all forced to agree that the selective pressures that led to the appearance of the remarkably plastic homo sapiens as the dominant predator species in Nature have ceased to be effective. They recognize that the less fit, whether measured biologically or intellectually, do survive and, even more significant, reproduce strongly (although the least

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<sup>1</sup> These insights were much discussed among scientists during the 1940's and 1950's as a reaction to the older social Darwinism and eugenics arguments from the ideologies on the right and Marxism on the left. For the latest formulations see Julian Huxley, "Evolution: Cultural and Biological", Yearbook of Anthropology (N.Y.; Wenner-Gren, 1955), pp. 3-25; C. H. Waddington, The Ethical Animal (London: Allen and Unwin, 1960); Sol Tax, Evolution after Darwin, (Chicago: Chicago, 1960); T. Dolzhansky, Mankind Evolving, (New Haven: Yale, 1962), pp. 20-22.

fit, the bottom 10%, do not). Thus the succeeding generations of man are no longer increasingly adaptable as individuals. A distinctive capacity to communicate, and especially to store knowledge, has however continued to enhance his ability, considered now as an organized social unit, to dominate the scene. Adaptation of individual behavior is made to groups, and groups find functions within corporate bodies, and the latter form social systems which cope with the exigencies posed by the environment. Thus the biological and anthropological theorists generally conclude that cultural evolution has succeeded biological evolution as a source of increasing control over surroundings. Cultural growth now appears to depend upon a population density of at least several thousand persons per square mile together with a diversity of backgrounds and interests among the individuals. The cities that can manage their pluralism so as to keep the inevitable friction at a minimum, and borrow ideas from elsewhere, seem to be evolving culture at the most rapid rates. Culture in this sense comprises range of sub-routines of orderly behavior kept on tap by an interdependent and directly interacting human community.

#### The Argument in Brief

This discussion of resource transformations began with a simple statement of the core proposition. Its significance was illuminated by raising one of the nightmarish prospects contemplated by the educated classes--the circumstances of life for people in general when the familiar natural resources are depleted. Such doubts naturally led to a question regarding the resource consumption implied by worldwide economic development. Would the supplies run out even before most nations had reached adequate levels of living? The answer cannot be reached by estimating supply and demand

because some of the more plentiful resources can provide partial substitutes for the critically scarce raw materials.

The possibilities of substitution forced us to reconsider what a resource really was, and the problem of precise definition led to the fundamental observation that the most abundant natural resources require a substantial body of knowledge to effect successful substitution on a large scale. Knowledge and the skills used in applying it, are regarded as resources also--human resources.

At this point the peculiar paradox of urbanism is spotlighted. Knowledge, organization and the other human resources are concentrated in the modern metropolis, yet the large cities are simultaneously consuming natural resources at an accelerating rate. On a per capita basis urban people consistently consume more than the rural members of the same economy, and cities are raising themselves above the surrounding plain on a mound made up of their own solid waste.

The only resolution of the paradox that seems to make sense is to accept the image of the metropolis as an engine of socio-cultural and economic development. The mechanism is energized by one set of resources and repaired with another. They together comprise the essential inputs. The outputs, besides the wastes, are a number of extra intelligences and organizations which have acquired some knowledge. These new assets cluster about corporate headquarters and government offices with only minor diffusion back into the countryside; thus the engine of development must continue to perform well even when its immediate environment is densely populated with experienced educated talent, a circumstance that an engineer used to calculating differentials between source and sink finds difficult to understand. However, repeated observations make it evident that some of the knowledge



output can be fed back to the engine and its efficiency may thereby be improved. Thus a simple cybernetic loop has been installed. Simultaneously the external physical environment is brought under increasingly thorough control of organizations with headquarters in the cities.

Clearly, man uses modern cities to get ahead of the threat of resource depletion and scarcity. At least that is what has been happening for the past two centuries and promises to continue for at least two more generations. This is a very different conclusion from that which is reached with the evidence presented by daily newspapers or even annual meetings of scientists. Is there, nevertheless, some truly critical resource (e.g., one that present investigators find intractable in the continuing search for substitutes) that can bring this evolutionary process to a halt? That question, too, demands careful study.

## II. What Resources are Critical?

Scores, if not hundreds, of large cities, built up with generations of hard labor, have disappeared altogether. They encountered a crisis they could not survive. The lesson that might have been learned was usually lost because there were few reasonably unbiased records of the events that led to their downfall; too often in the past the histories have been written by the conquerors, who usually attributed the destruction of the city to the valor of the heroes among the attackers, the significance of the omens, the strength of their prayers, or the rightness of their cause. Occasionally neutral third parties were on hand who did their best to render an objective account. More rarely still, the teams of archeologists, which are now made up of a variety of specialists, have pieced together an explanation centuries, or even millennia, after the fact. Thus we have been able to deduce something about the specific underlying stresses brought about by resource scarcity at the time of catastrophe, but this is a very tentative kind of analysis.

It is not surprising that ancient history provides us with no satisfying statistics on the causes of apocalyptic death for great cities, such as befell Carthage, Babylon, Nineveh, Antioch, Pataliputra, Bagdad, Ch'ang An, Teotihuacan, and the like. Nor is there an assessment of the reasons for abandoning cities such as Memphis, in the Nile Valley, Angkor Wat in the Mekong, the large Mayan centers in the Yucatan jungle, the ancient settlements in the Indo-Gangetic plain, or the early Yoruba aggregations in old Ghana, except that people appear to have become less numerous, less productive, and apparently disinterested in urban life. Partial explanations abound because quite frequently we can discover that a harbor was silted in, a water supply lost due to the changing course of a river, the soils of a

vital hinterland were worn out and eroded away, an ore body was depleted, or a great epidemic swept through the population.

In other instances, a chain of natural events may be triggered by customs and obsessions of the dominant classes. Thus the patrician Romans in the villas of a reconstructed Olympia, site of the world-famous quadrennial games, could hardly anticipate that their baths would cause them to be buried in sixty feet of mud and sand. The wood to fuel the hypocausts was cut on the hilly flanks of Arcadia much faster than it could renew itself, so a record rain set off a huge landslide, thus preserving much of its integument for posterity. Similarly, the Romans did not understand the risks involved in building Pompeii, which was buried by the same vulcanism that produced its hot springs.

Factionalism in the key political and sacred institutions has always been a threat, because without central authority for collecting taxes and tribute the hierarchy atomizes and the people of the city dissolve into the folk society. Until the eighteenth century military superiority provided by the technics of the city was an almost universal prerequisite for survival. The continued existence of cities has depended upon unified corporate organization, originally in the form of temples and royal households, later guilds of artisans and trading companies, but eventually representative government. (Gideon Sjoberg, "The Rise and Fall of Cities," in Nels Anderson, ed., Urbanism and Urbanization, (Leiden, Brill, 1964), pp. 7-20; E. A. Gutkind, International History of City Development, (Glencoe: Free Press, 1964).

Recent history, however, is different. No large city has been extinguished by war, revolution or natural disaster. National social institutions and modern technology have synthesized over time a most remarkable capability for healing wounds, so that the great destruction of World War II rarely required

as much as a decade to overcome. Even Hiroshima and Nagasaki are larger than before. We must be living in a Golden Age for cities because, despite their defects, millions of people are actively trying to shift their residences to them. Even though the great cities are targeted by several long-range ballistic missiles on the other side of the ocean with payloads designed for their obliteration, and the fact is recognized by the educated immigrants, it is this educated group in particular that exhibits the strongest preference for the metropolis. Thirty or forty more urban centers are expected to move into the million size category over the next decade. Nevertheless, golden ages come to an end, and they often give cues or clues to the transition in advance.

A closer examination reveals that the great cities have been going through repeated small-scale crises. These trials are worth reviewing because a catalogue of "near misses" serves as a fairly good forecasting device. They point to many of the greatest hazards that urbanization faces in the future. (See Table Two)

The idea that cities are being tested continually by small-to-medium catastrophes and that their responses to these events set the precedents for the reaction to great catastrophes is an appealing one. Current world history might be assessed as if it were a gigantic natural experiment; great cities in various parts of the world must meet scores of threats that strike at essential operations over the course of only a decade. Information on the frequency and source of threat should enable city planners to prepare defenses against disasters that have yet to occur. Nevertheless, attempts to carry out such a program of investigation of recent urban history very quickly reveal a number of inadequacies both in the concept and in the data.

It was thought, for example, that urban catastrophes could be compiled in much the same way that the reports of wars and revolutions in the nineteenth and twentieth centuries have been identified and chronologically ordered. Human costs have also been quantitatively estimated in most instances. However, catastrophes for cities were revealed to be different than for nations, primarily because the latter have legally defined the occasions for waging war and citations for the crime of rebellion, while cities have precisely identified very few of the threats to their existence. The first "catastrophe list" that was compiled for world cities contained two classes of phenomena: one was a series of threats to survival which were completely averted, followed by sighs of relief, and the other designated events in which damages were sustained, but only by a readily dispensable precinct or ward. The list much more resembled a batch of medical reports from a loosely interrelated population of patients which mentions epidemic prevention and antibiotic distribution in the same context as broken bones, fevers, digestive upsets and expressions of pain, but no deaths. The insight is important because the welfare of cities had properties closely paralleled by the concept of the health of a group. The latter is known on the basis of much study to be measurable in many of its multitudinous aspects, but not as a whole, so the analog stimulates a comprehensive assessment. Employment of health-related terms is more suggestive than mere parable; it may well offer the most suitable paradigm.

News stories reveal great differences between cities. Some are loud hypochondriacs, while others are uncomplaining stoics. New York, for example, exhibits a long sequence of urban crisis headlines, but Shanghai's complaints

reduced to a few strings of characters by the time they reach nearby Hong Kong, are restrained. News of impending crises may be selective, since reports that entail loss of face may not be reported at all in Asian and African countries. Thus we are forced to discriminate between tub-thumping promotional cities that demand the attention of everyone around and the poor, ailing, powerless, undefended cities that seem unable to express what is happening to them in a way that can be understood. The former is a high level transformer of resources, while the latter consumes at a much lower intensity. Just as the doctor must appraise the effect of the injury upon "normal" human development, we are forced to specify an orderly development of million size cities so as to amplify the laconic accounts of some cities, and discount the dramatics of others. To which resource scarcities are cities most vulnerable, and how do these scarcities rank with other crippling or stunting disasters?

#### Urban Water Hazards

Indubitably the most serious difficulties with natural resources experienced by large metropolitan areas are those with water. Table One demonstrates the relatively huge volumes required in America and even in India to flush away the wastes and to cool the power equipment. As the population and the industry of a city continue to expand, whole new watersheds need to be dammed up. Their normal flow is then pipelined to the smaller reservoirs in the metropolitan area and from these points distributed through the urban grid. Water authorities are formed to reach far out into the hinterland and purchase the rights to the runoff. If this acquisition is not undertaken well in advance of need, the occasional droughts that affect virtually every urbanized region and its water catchment areas will bring industries and sanitary systems to a halt.

The sequestration of water is most difficult in densely populated regions where rural communities have already established claims. Since the cities in most of these regions are relatively poor and cannot afford to build up a strong safety factor in the form of up-country reservoirs, they are forced to find some way to ration the limited water supplies about once every decade or more often. When this happens, announcements are made through the newspapers, and over radio and television, that there will be no pressure in the pipes of the city water system except between specified hours. Meanwhile, water carriers and tank trucks ply the streets selling water just as they might otherwise sell milk, kerosene, or vegetables. A shortage of food, particularly the perishables that are usually grown close at hand, is likely to follow the onset of drought. The combined difficulties are often sufficient to scare off the potential immigrants and keep them out of the metropolis. If the drought continues into a second or a third year, the parched metropolis is likely to experience an inflation in food staple prices as well, thus creating a condition that will drive poor people back to their villages.

Large cities that have grown up near the headwaters of river systems are most vulnerable. Examples are Mukden and Sian in China, Delhi and Hyderabad in India, Bogota and Caracas in South America, Pittsburgh, Denver and Dallas-Fort Worth in North America. The upper watersheds they draw upon tend to have a greater year-to-year variation in precipitation than the full drainage basin. In dry years these cities are likely to use the total flow available, draw down the reservoirs and pump heavily from the aquifers underlying the city itself. Many such aquifers rest on a base of dense brine, so continued pumping from such strata results in increasingly saline water.

There may be adequate supplies of fresh water a few hundred miles downstream, but it does not pay to build an upslope pipeline that could be rendered useless for a decade or more by an ordinary rainstorm. Since at least two years would be required after the time of decision to put such an aqueduct into operation, the likelihood of regret is exceedingly high.

It is not at all easy for a metropolis to go into the countryside and buy up water rights. Inevitably, the political leaders in the rural communities come to regard this action as one that robs them of their future. The repercussions in the legislative assemblies and the parliaments are highly undesirable. Leaders at the state or province level hear repeated stories, some true and many false, illustrating the unfairness of the urban authorities to ordinary people when building dams and reservoirs. Often sizable villages are displaced from their traditional sites. Naturally the rural representatives respond to the threat by forming coalitions to repel invasion from the metropolis, even if it is the dominant political center in their own state or province. Almost always the rural population is over-represented in the legislature; therefore it possesses an unusually strong veto power.

The typical solution available to the growing metropolis is to pay for the same water two or three times. It must of course provide the scarce leadership and the capital for a regional water authority that has the power to collect the water at convenient points. This authority will find its actions bound by compromises in its charter which provide water for people in the vicinity of a constructed facility at rates a third to a tenth of those charged in the metropolis. However, to obtain passage of such an authority with broad powers for water resource development, the metropolis must "bargain"



for votes from smaller cities and some rural areas. It must promise to support independent legislation creating industrial estates, harbors, airports, technical colleges and other installations at uneconomic sites purely because they are desired by the provincial elites. The metropolis creates the bulk of the taxable income and property, so the taxes applied to such projects derive from metropolitan services, and a water authority becomes a device for redistributing the added value created by urbanization to people who have thus far remained away from the cities.

Woe be unto the metropolis that finds its water in an adjoining state or nation, because it is then not in a position to bargain directly. It is likely to pay, pay and pay without being sure of delivery even then, because extraneous issues can always be interjected due to strains in the relations between large political units. Everywhere in the world the subject of long-term water supply seems to be synonymous with political intrigue. Fortunately, large cities do not grow up in deserts, because there the occupants of the land go one step further and enforce their claims to water with private armament.

The normal effect of a great drought, such as that experienced by New York City in 1963-65 and Hong Kong somewhat earlier, is to cause the water-using industries engaged in production for customers outside the immediate region to place their next plants in urban areas where water is more secure. Quite often this is downstream for a river-based city, while estuary-based cities with shortages find themselves pushed into a flurry of water supply expansion activities by these same interest groups.

Often higher-cost substitutes are installed so as to reduce future vulnerability to drought. Thus, bottle washing and sterilization for reuse in milk, soft drinks, and beer distribution is displaced by steel and aluminum

cans and by plastic-coated paper. Of course the new containers greatly exacerbate the solid waste collection and disposal problems faced by these cities.

The large modern cities located on estuaries and shorelines have one great advantage over those on rivers; they can draw upon the salt or brackish waters of the sea for the large-scale cooling requirements of power plants and energy-intensive manufacturing. If fresh water gets dear enough, they are in a position to fill a minor portion of their needs with desalinated water produced as a by-product of these industries, but this is likely to happen only when the cost of adding extra water supply capacity equals the maximum experienced by a million size city in the world today.

Much loose talk can be heard about the ease of cutting the supply lines to a city or introducing some toxin into the water that would make it unfit for use. This is far more difficult than it appears. Even in Bombay, which is supplied by two large pipes side-by-side running above the surface for many miles (because the city rests on a rather narrow peninsula and its sources are inland), it would take the authorities only a few hours to replace a length or two of pipe or a valve that might be destroyed. Water requirements for several days are held in tanks and reservoirs within the city. The presence of contaminants would be detected hours or days before it reached the bulk of the city regardless of what point it was introduced. Moreover, many of the poor get their daily water from the barrelmen who draw it from a few wells inside the city. Most inorganic contaminants would be held back for a while by the sand filters that are routinely employed, while the biologically active materials are very likely to be inactivated by the chlorine that is added. An extremely skilled and well-informed agent might

overcome these difficulties, but such a person could probably have a greater impact when attempting to halt other departments of government, and it should take less physical effort.

It may seem bizarre to take up such eventualities but the list of rebellions, riots and strikes affecting great cities is longer than the "near misses" on water supply. Successful cities must be very open systems, so it is impossible for the city to prevent the entry of agents seeking its destruction. If the Bombay water system seems to be able to cope with foreseeable emergencies, then it must be quite a bit simpler for its counterparts elsewhere in the world.

All metropolises still have a major untapped water resource which exists only because of an unwillingness to act counter to a prevalent taboo--the waste waters from almost all the sewage treatment plants could be reprocessed at a cost that is less than that of acquiring new supplies. The reprocessing technologies have been known for more than a decade and they have been tested repeatedly on a pilot scale. This alternative poses an embarrassing dilemma for the urban leadership. Should it pay excessive charges for future water supplies upbasin, due to the extralegal claims of local interest groups, or should it try to overcome the nausea of its own predominant majority that holds the taboo against "consumption of human wastes"? The best policy appears to be that of investing in "education" and public relations with the aim of deflecting the taboo from reprocessed waste water. Eventually then the water would sluice through a city in times of surplus; in normal times it would be recycled several times before it escaped; in times of great shortage it could be reprocessed to the point that it disappears as water vapor rather than as fluid.

Energy Crises

A city that does not import energy sources for its internal operations is dead. It can be shown that even the efficient technologies for exploiting sunlight cannot support people at urban densities, nor could they devote themselves to an urban way of life (Meier, 1966). A large natural gas field immediately underground could support a small to medium size city but would be exhausted too quickly by a metropolis. A rich coal seam underneath the city is ruled out by the combination of the heap of spoil that would be produced at pit heads and by the settling of the surface caused by underground cave-ins. Thus, the larger cities are universally fuel importers on a huge scale. Normally they bring in more than 99 percent of the fuel or electric power that is needed to operate the city.

No metropolis has experienced a really serious failure in the importation of energy since World War II, unless one wishes to include Seoul in 1950-51. Seoul at that time had not yet reached the population of a million. In the 1940's coal was still the predominant fuel, while oil often played a significant role, so the bulk of the imports, even in a relatively poor metropolis, was very sizable as compared to building materials and food. This meant that every time the rail lines and harbor came under attack, the inflow of fuel, food and most reconstruction materials would be simultaneously cut off and the respective stocks on hand would need to be rationed. Energy shortages were always accompanied by a lack of adequate shelter and by hunger; therefore, energy shortages are not an easily isolated threat to cities. Seoul's experience is matched by that of large European cities in previous decades.

Threats of invasion since the construction of the autobahns have almost always resulted in a military takeover of road transport, in addition to rails and harbors, and civilian needs were consistently assigned low priorities in the allocation of equipment. Actual occupation by the enemy during wartime did not result in improved access to food or fuel. Therefore, the great cities of Tokyo, Berlin, Leningrad, Manila, and Athens suffered grievously during the 1940's.

Several predictable consequences were identified following those breakdowns in energy supplies. The most observable effect was the reduction in activity of all kinds--economic, cultural, physical. Another was the emigration, since all the cities mentioned above were reduced in population by more than half within a period of one to two years after the onset of attacks upon them, and only a minor fraction of the loss was due to war casualties. Almost all of the urban families with relatives or some kind of property holdings in the countryside thronged the escape routes. These refugees were joined by citizens on day trips who went foraging throughout the outskirts for food or lower grade fuels. Thus the forests in the parks and the green belts were almost totally removed, and even some of the peat bogs were dug up. Damaged buildings were scavenged for edibles and combustibles. Materials like paper became extraordinarily scarce at the same time.

Once hostilities ceased, however, supplies of kerosene and wheat flour were quickly moved in; technicians patched up the electric power distribution grid within weeks, or at most, a few months; electric power generating stations were put into operation even more speedily. All during

this accelerated reconstruction period the people flowed back. Indeed the pace of resettlement proceeded to such an extent that all these cities passed their former peak sizes within a decade of their nadir, even though housing and office space remained desperately scarce for more than another decade thereafter.

Never before had large cities recuperated so rapidly from such extensive destruction. This resilience in the face of great damage is attributed in part to electrification, but the modern bureaucracies managing other utilities and services in the metropolis should be given equal credit, since in each case the organizational framework had not been totally destroyed. The surviving elements retained the capability for recruiting and training individuals to fill the gaps. Bureaucracies heal wounds more quickly than the guilds of artisans and merchants that preceded them, and energy utilities such as electric power, gas, petroleum products distribution, and railroads ranked among the most advanced bureaucracies in each of these cities.

The ability to recuperate has advanced much further over the past thirty to forty years. Power plants can now shift quickly from one fuel to another. Essential intracity traffic could be maintained with propane or even methane. Elaborate power grids have been constructed to provide back-up power for the city in case of the shutdown or loss of a captive generator. Many of the networks linking up the metropolis must be placed under ground or under water and, therefore, they are not easily severed. Telephones are increasingly independent of the availability of electric current from the regional grid so that systems of exchanges can work even when all the lights are out.

Presence of the regional grid has, however, introduced a new and unexpected vulnerability. The Great Blackout of 1967 affected almost twenty million urbanites in the New York, New Jersey, Pennsylvania and Ontario area for a whole night. Lesser failures have occurred since then in several metropolitan grids, and in some cases their origins remain totally inexplicable. Although in those instances subways and elevators stopped, and thousands were trapped, most buses and cars remained operational. Henceforth, a number of back-up generator units will be on hand in headquarters areas, thus reducing the vulnerability of the large city to electrical energy supply failure even more than then.

Each modern metropolis is simultaneously fed by gas and oil pipelines which are sometimes advertised as "lifelines." The image of vulnerability inherent in the term has attracted the attention of a number of ideologically committed saboteurs. They did not know that considerable buffer stocks and inventories are maintained in underground reservoirs which will serve the needs of the residents for days or even weeks. Emergency repairs require much less time--hours or days. In the long run the pipelines will be recognized as a network of dependable supplies that contribute to the prevention of shut-downs.

No other experience has come to hand to demonstrate that in the future large cities would be exposed to new disasters due to the inadequacy of the energy distribution systems. Their planners have worked out a number of strategies that allow the big cities to become relatively autonomous in the short run. In the long run a number of fuel substitutes can be mobilized, particularly if the population served includes a body of high-quality technicians.

Another Kind of Human Resource

While strongly persuasive evidence can be assembled to show that the physical fabric of the city is now mended more rapidly than ever before, there are some doubts that damage to the sociopolitical system can be as speedily repaired. Recent widely publicized riots in American, French and other modern metropolitan areas caused much physical destruction, but they took an even greater toll from the amount of public cooperation that had been achieved outside of the firm and the workplace. Urban order is a human resource; it includes at least (1) tolerance of others different from one's ingroup, (2) consensus on the rules governing public behavior, (3) an acceptance of the legitimacy of the courts in the settlement of disputes, (4) admission that carefully constrained police powers are needed to enforce the authority of the courts, and (5) willingness to follow a responsible body of leaders. The resource is depleted when divisive issues cause polarization and trust--the basis of cooperation--breaks down.

The characteristics enumerated above are all needed to expedite the bargaining between individuals and groups without recourse to threat or the use of violence. Coercion-free bargaining is the basis for urban order. Informal arrangements for completing social, cultural and political transactions are almost always more efficient than the formal procedures, so the degree of utilization of informal social process appears to be an indicator of the order that has been achieved in that urban region. Calcutta is perhaps the prime contemporary example of a metropolis that has not developed this kind of human resource in a way that will contribute to its progress. Calcutta has always been a city of many ethnic and religious



communities accompanied by large numbers of unattached men whose allegiances remained tightly bound to family and village somewhere in the accessible hinterland. Its severest trials, however, began at the time of the partition of Pakistan from 1947 to 1951. In the huge population exchange that resulted Calcutta lost its educated and organized Muslims, while the Mohammedan contingent that remained was of the very poorest level. The metropolis received many more Hindus, so the majority were forced to settle on the fringes of the existing metropolis outside of the Corporation boundaries. The new international boundary sliced off almost half of its hinterland just at a time it needed to support a big influx of settlers. The social fabric has not recovered from these shocks.

Frustrations experienced by different elements in the population led to strikes of all kinds, food riots, violent political demonstrations, local pogroms, student disturbances, and a sullen resistance to authority on issues that presented little difficulty elsewhere in India. An established profit-minded clique maintained its hold over the Corporation and the Improvement Trust. Calcutta's businessmen extracted every rupee of profit possible from the urban milieu without being able to get together to build the new public services required for growth and development over the long run. Other great cities in India produced some of the cooperative effort that was needed but businessmen and other community leaders in Calcutta did not bother to defend themselves against charges of neglect; they could only say that they were compelled to play the game of survival in a different way. The heads of leading families seemed not to be able to communicate with each other on development because each group, however it defined itself, aimed to get justice

for itself first. Life was conceived as a negative-sum game in Calcutta; a feeling of frustration and powerlessness has prevailed. It is a condition that remains to be dispelled.

Although actual delivery of urban services has reached a much higher level in American central cities, the present outlook for their residents is equally problematic. Again the specific impact of immigration has generated a series of unsettling trends. Any application of pressure on the part of the most recently arrived "under class" now living in the central city for a fairer distribution of the services causes a decline in the standards of performance elsewhere in the city or else the added effort required to maintain quality leads to sizable increases in the property taxes. Either choice will accelerate the flow of older residents to the suburbs. Losses of markets by the central city merchants, and reduction of the value of property relative to salaries, brings about further shrinkage of the financial base. Given such a dismal future, each organized constituency in the central city decides that it must look out for itself first and thinks of participation in the larger community as a means of expediting these interests. Each group feels it is being exploited by the others, because the poor have few compunctions about cheating the welfare services, and the better off firmly believe in the right to evade taxes with low financial risks. Few channels of cooperation remain open so long as these images of irresponsible behavior are dominant.

Splintering and dissension in the social and cultural spheres is equally evident in these American central cities. The values of the new residents do not match the middle class norms maintained by those who had lived near the center but then left for the suburbs; both legal institutions

and the police are under attack; the charisma of the leader rarely extends beyond his face-to-face group; shared expectations regarding behavior in others have declined. Deep suspicions of other groups give place to frustration and rage. Eventually they lead to bursts of meaningless violence directed more at the inanimate environment than at persecutors or competitors. The latter are dehumanized to rats, pigs or insects before they are attacked. Violence destroys the social order even more rapidly than contrary ideology-- a principle all revolutionary agitators recognize. Violence increases the need for restorative forces--the synthesis of new or reorganized institutions for maintaining order in the most complex locales of the metropolis.

These appeals for urban order sound reasonable enough when put into words, but how will officials be able to measure or compare alternative proposals for halting the slide toward chaos? What kinds of indexes can be used to represent the various dimensions of this kind of human resources? The following unrefined categories represent a minimum flow of information that should be taken into account:

1. Common icons or grand symbols. Citizens and sojourners will recognize that their own metropolis possesses certain elements of style, both in physical form and in dramatic flair, perhaps also in speech, that transcend class, race or religion. This mutual understanding of collective behavior is a powerful indicator of prospective unity in the face of adversity. (Interestingly, the search for grand symbols failed in one instance, Kanpur, a metropolis of almost one and a half millions on the Ganges River, had no postcards, brochures, chamber of commerce promotion, or identifying landmarks. It also has an exceedingly low level of collective action for community ends. (Meier, 1970)

2. Overlapping memberships. Some organizations claim members who are connected to many different kinds of viable organizations operating in the same metropolis. Thus the number of "bridging" participations should be highly illuminating statistic to maintain. (This proposal is an outgrowth of the strong and continuing interest in America in the community power structure and in conflict resolution mechanisms.)

3. Conformance to some externally established service standards. Such outside standards include examinations in schools as set by the state, recreation and sports performance levels as judged by inter-city leagues, network television programming, quality control in supermarkets and shops, the language to be taught in public schools and expected on public occasions, etc. Non-conformances are often easier to find and count, and could constitute an inverse index; unfortunately, there are some instances where they become a part of style as introduced above, so these components must then be eliminated from the index. (There will be much disagreement regarding the relative contribution of various activities to public order. As a first approximation, authorities should weigh according to the amount of human time or effort put into the activity.)

4. Intersecting trips on transport systems and public routes. The willingness to seek opportunity must be conserved. This means that urbanites of all kinds must retain the right to travel freely. We know that ghetto dwellers tend strongly to restrict their range of movement voluntarily, while "bridging" roles move about most widely. Such an indicator of mobility also helps explain localized traffic congestion; overloads there tend to trigger local disorders. (Probably all million size cities have by now undertaken traffic studies. However, many have neglected the pedestrian movements because somewhat different techniques of investigation are required.)

5. The content of the public communications. The frequency of appearance of certain key terms or concepts in public talk, newspapers, radio and television programs originating within the metropolis can provide sensitive indicators of the public order. Appearances of new terms indicate a healthy capacity to borrow ideas in those urban activities with which the concepts are connected. (Content analysis is a difficult, time-consuming and often unrewarding technique. It is most useful when carried out in conjunction with benchmark surveys of public attitudes and opinions.)

6. Events suggestive of social pathology. The occurrence of quickie strikes, breakdowns in discipline, vandalism and unusual increases in non-participation require independent investigation by some ombudsman-like agency because the reporting by the bureaucratic officers immediately affected is inevitably biased. (Many cities are sick and refuse to admit it, while others are merely hypochondriac, reporting their minor upsets at great length.)

Social scientists will note that the recommended measures do not depend heavily upon survey research but rest much more upon unobtrusive observables, so that the city should report upon itself. One reason for this choice is that the routine polling process is already quite expensive, yet it rarely provides enough detail. Moreover, when the urban system is subjected to some internal stress, we now know that the most affected individuals are often unwilling to speak frankly to an anonymous interviewer. Thus some of the key strata are likely to be under-represented in the sample at a time when such information is of greatest value to the urban policy makers.

The concept of order in large cities is best visualized as a multi-dimensional web knit together in networks with distinctive patterned relationships that are frequently reproduced. The web is easily deformed under stress,

causing friction and perhaps even rupturing some bonds. In cities with gloomy prospects, the bonds are being broken more rapidly than they are repaired or replaced, so that the overall order is dissipating.

New organization and activities must be stimulated to halt the slide toward dissolution. They introduce new knots into the web; they produce new bonds in the networks after some lag. Even Calcutta generates a wide range of new organizations each year, particularly around its periphery. They include a number of new holding companies, small modern enterprises, still smaller traditional enterprises, private schools, governmental offices, political associations, sports clubs, dramatic societies, professional groups, religious missions, neighborhood organizations, cooperatives, etc. The difficulty is that more seem to be stultified, moribund, or going bankrupt. Therefore, on balance, Calcutta is not producing the new organizations that are needed to mobilize its human resources and produce expanding loci of order in its metropolitan area. A highly developmental metropolis, such as Tokyo, may have as severe a mortality rate for organizations as Calcutta, but Tokyo maintains a kind of civil order that greatly eases the task of starting and building new organizations (Meier, 1969, 1970). When the birth rate of organizations is greater than the death rate the metropolis moves ahead--first in terms of increased social participation, then in economic efficiency, then in political stability, and finally in externally recognized cultural achievement.

The creation of new organization presupposes a capacity to communicate. The city must install a variety of media that transmit information, preferably in an unbiased form. Thus the information regarding a new opportunity and justification for forming a new organization most often arrives in specialized journals and catalogs, but it is reinforced by word of mouth reporting and perhaps

with photographs. Consider, for example, the establishment of a technical library, an art center, a housing cooperative, a private school, or a new manufacturing enterprise. The initiative is taken by a promoter, who through a series of face-to-face encounters persuades others that this project offers a profitable use of their time. He finds the financial backing, chooses the operating site, and starts instructing others about the most efficient ways they can contribute. Then he must turn his attention to the consumer of the new goods or services he intends to supply. The potential users must be found and then persuaded that this product is clearly superior to the existing alternatives. The most economic strategy for persuasion generally requires the use of several communications media in a way that allows them to reinforce each other.

Then, when a formula for selling the product has been found, the organization must expand rapidly to fill the niche that has been created. In doing this the promoter must look for suitably educated or trained people in the moribund or dying organizations and fit them into his organization. The dense settlement of a metropolis allows a promoter to draw from a large pool of potentially valuable preprogrammed (trained, experienced, or educated) individuals and thereby construct a finely tuned and sensitive organization in a matter of a few years. The outcome for the metropolis is a new address where people have relatively stable long-range expectations and engage in orderly, integrated, productive action but depend heavily upon the communications channels for continuing operations.

#### The Communications Resource

New organizations can save cities, and such organizations are made up of urbanized people held together with the aid of communications capability. Without

this capability societies would be unable to find new deposits of minerals, develop substitutes for depleted resources, or increase the efficiency of the consumer. Each time a metropolitan area undertakes a significant adjustment in its use of scarce natural resources, it is forced to construct a whole new communications sub-system to back up the promoters of the innovation in resource use.

The evidence that can be presented for water and energy is quite typical of the array of communicated information required. Whether the capability is measured in messages transmitted, items of data stored, or circuits rented, the new capabilities installed are usually found to be ten to a hundred times greater than what was required for the predecessor technology. No instance has yet been discovered in which the total amount of communication involved has actually become less after a substitution has been effected. Thus the using up of the standard natural resources puts continuous pressure upon the communications media and the underlying telecommunications technology. They draw upon an environmental resource as ultimate as that of solar energy--the electromagnetic spectrum.

Fortunately, the number of channels that can be provided by the spectrum is very large. They are treated as a free good by member countries of the International Telecommunications Union. Moreover, marginal costs of both information storage and transmission are still declining even though the marginal costs of every other natural resource are constant or rising. Thus the unit prices of commodities will be increasing in the future, while those for telecommunications are expected to decline for at least several decades.

The diverging trends in these costs are extremely important for the future of cities. Their significance is best understood in terms of specific



alternatives. What must the average metropolis do next in order to reduce its vulnerability to breakdowns in the supply of resources? What bodies of knowledge would be drawn upon for obtaining extra supplies of water and energy? For increasing the efficiency of utilization?

### Water Conservation

As compared to other urban imports, the organization of water distribution is still rather primitive. It rarely requires as much as five per cent of the overall investment in million size cities. However, this share must increase markedly in the future at the expense of other sectors, so the pressures for rationalization will be strong.

The water program would very naturally begin with attempts to acquire known supplies in the hinterland or to expand the capacity of existing reservoirs. Common sense would dictate that a systematic geological exploration program be undertaken simultaneously. Its principal aim would be to discover aquifers with a quality useful for metropolitan water supply. This survey entails much drilling and a careful comparison of the cores. Experiments would be undertaken to discover the origins of the water and the rates of underground flow. In general, about as much information would be collected within a few years as had been assembled regarding the hydrology of surface waters and top soils in an equal number of decades preceding. With such data it should be possible to identify the best sites for wells and to predict their probable capacities. These underground reserves are usually a better hedge against extreme drought than the expansion of reservoirs.

Water management is even more susceptible to systematic design. The water collecting capacity of each minor valley and tributary needs optimization--an operation that nowadays requires significant amounts of instrumentation for the

automatic measurement of rainfall, runoff, erosion and transpiration. That information must be relayed to some data center where it is recorded and used for making decisions regarding the release of water to the lower reaches of the watershed. Flood control becomes an increasingly important justification in system design, but remains an independent factor utilizing different information networks.

More aggressive tactics are also possible. Vegetation on the steeper slopes of the basin can be modified so as to reduce transpiration losses, but then more data must be assembled on costs so that it can be determined when this approach no longer contributes significantly to the water supply. In limestone country, the bottoms of reservoirs may need to be plugged with concrete or blanketed with plastic film so as to reduce percolation into subterranean channels. In still another direction, options may be secured by cities for the withdrawal of water from irrigation agriculture during a drought. In all these instances the city will, of course, need to pay a significantly higher price for the delivery of fresh water during periods of scarcity.

Water distribution economies can be immensely effective when coping with a water shortage. We know that no one keeps records of water use when fresh water is free, and the records are still very scanty when a single quality of water is distributed at constant price according to the demand. However, if more than one quality of water were to be purchasable, and the prices varied inversely with the supply, a quasi-market in water would develop. Such an institution would eliminate much wasteful consumption; moreover, the attempts of the larger water-using industries to predict future price trends would require that these firms henceforth spend significant amounts of corporate effort digging into the information relevant to future supply and demand. Part of what is saved in the form of water charges must be spent upon information processing.

Finally, attention needs to be directed to the new science and technology affecting water resource use. Desalinization of sea water and the reprocessing of waste water so as to improve water quality comprise two of the best known fronts on which major advances have been achieved. Huge amounts of laboratory and pilot operation data need to be collected concerning the performance of various alternative designs. Then the strategic location of a new fresh-water-producing facility can be determined. The site choice is somewhat dependent upon the predicted future spatial distribution of customers, so the trends in water utilization data must also be analyzed.

The overall effect of economies at the points closest to the consumer might well reduce net fresh water consumption. For a modern city the net consumption of 50 gallons or less per capita per day (instead of the more normal 150 gallons per day) could be maintained without significant disruption. In the transition, however, the accumulation and dissemination of water-related data would need to expand a hundred-fold or more. Such magnitudes are readily handled even today with computers and co-axial cables, so the information technology seems to impose no foreseeable constraints. The principal known limitations are legal archaisms which allow claims that prevent the transfer of water across property lines and political boundaries. Administrative reform is likely to be the principal slow step in the achievement of water conservation.

#### Energy Conservation

Fuels are generally worth about 100-1,000 times the value of an equivalent tonnage of potable water, so the policies underlying energy conservation have become more elaborate. Due to the added worth, enterprises find it economical to move fuels by tanker, pipeline and rail to major consumers anywhere in the world,

even in the opposite hemisphere. Fuel markets with differentiated commodity quality have come into being in a number of exporting regions, but elsewhere we discover a set of administered prices that respond sluggishly to world market trends. The existence of some relatively unrestricted markets assures that future shortages in the supply of fuels should lead to a halt in many of the least economic uses of energy, but waste is still far from having been eliminated at present. With better distribution of knowledge, and modernized laws and regulations, all the world's work could probably be done at the same or lower overall costs and with about 20% less energy, according to my own estimates.

Technologists generally include electric power generation, transport and much of the metallurgical and chemical industries as components of the "energy sector"; the aggregate of these energy-intensive industries requires up to 40 per cent of the capital employed in a modern metropolis. This level of investment of hard currency cannot be afforded by Asian societies; therefore, their cities are likely to be among the first to program projects for economizing on energy use. The share of overall investment that appears to be required for the development of countries without sizable gas and oil pools forces these countries to consider import controls and rationing--if they have not already adopted a set of such measures. When the hardpressed countries set out to conserve energy, the practical policies that they feel forced to accept are similar in many ways to those already described for water conservation, but they are more subject to controls exerted at national boundaries.

Every nation is forced to prospect for oil and gas within its own territory; most recently this pressure has been extended to include the continental shelf offshore. If, as in Japan and Italy, the geological opportunities are

minuscule, the government-sponsored firms must undertake contractual relationships with countries endowed with a good production potential. The exploration process is a gamble with exceedingly high stakes where the risks are made reasonable only with the acquisition of huge quantities of sub-surface information. Alternative sources of energy, such as coal and shale, employ technologies with much less informational demands, but their anticipated overall costs per horsepower-hour over the next decade or two are projected to be greater. Therefore, their use ought to be postponed until oil and gas fields are depleted.

The transport, refining and conversion of gas and oil quickly evolves a "fine tuning" of the flows so as to prevent spills and to direct the products to the customer at the proper place and time. Microwave relays parallel the pipelines and manage the expansion of their capacity, while high capacity on-line computers make the routine decisions in the refinery-petrochemicals complexes about the quantity and quality of the respective outputs. Monitoring information from all around the world is continuously transmitted to headquarters installations in New York, Houston, London, San Francisco and Tokyo where decisions are made to readjust policies in the light of information regarding new technology, finance and politics. Much attention is concentrated upon the progress of an even more highly instrumented and controlled energy generating technology, that of nuclear power centers, because the largest consuming units may henceforth employ uranium. All these projects imply that electric power should be available to metropolises at constant or even slightly declining costs, even though depletion causes the carboniferous fuels to enter a period of rising costs, and diminishing proportions of oil, gas and coal are converted into electricity.

Some Asian and African societies will experience a much more desperate shortage of foreign exchange, as well as liquid fuels than at present. They will be forced to investigate much more carefully the substitutes for the automobile intra-city transport. Because congestion tends to slow down such vehicles to 8-12 miles per hour, and their exhaust causes extraordinary amounts of localized air pollution, it is not too difficult to design a cost-saving, energy-conserving system for moving about people and goods within cities. The most promising substitute for the automobile mode of transport in the contemporary metropolis is mass transit combined with lightly powered cycle-scale vehicles and diesel buses. The integration between these modes can be managed by computer and telecommunications. Extra economies can also be achieved by spreading the period of peak loading of the system, but experience in World War II and occasional experiments thereafter indicate that a huge amount of information transfer and much bargaining at the political level is required before substantial load shifting can be accomplished. Accommodations must be made for each passenger for journeys to work, to school, to the bazaar, and to recreational centers while each of these destinations may change several times a year; thus the million-size metropolis will have to make tens of millions of brief consultations per year, and continuously redefine the optimal schedule. Preliminary estimates suggest that even for metropolises the scale of Tokyo or New York the typical fare could eventually be reduced to something less than ten cents and the overall energy content in typical trips would be similarly reduced. Populations only a few notches ahead of subsistence could afford at such prices to move about in the metropolis and participate in its culture. These economizing issues will be taken up more thoroughly in the context of space-time tradeoffs.

It is evident by this account that fuels can be converted into more electricity, passenger-miles and fabricated products when aided by communications. The direct substitution of trips by messages, whether by mail, telephone or broadcast channels, has not been claimed although the potential energy economies are obviously very great. A trip usually produces face-to-face communication and immediate human affect in addition to the communication of symbols, while the various media produce other kinds of bonds between senders and receivers. For example, school children report that computer teaching machines are much fairer than human teachers. We still know too little about this substitution process in urban society to be able to gauge the full sequence of adjustments in behavior so institutions must be very alert as they substitute.

#### Human Resource Development

It has already been argued that human resources constitute the knowledge and the organizational capabilities that a society has at its disposal. They include the experience and skills of the members, taken singly, in groups and in collectivities, as well as their capacity to learn more. Human resources are developed through learning; the task is accomplished first by acquiring the ability to speak the language, then by learning to read and write, later to use tools and equipment and find one's way in the immediate environment. All this implies a heavy investment of effort on the part of the new entrant into the society, whether it be child or immigrant, and not an inconsiderable amount by the society itself. Only then is a person likely to be able to find a situation or position in some organization that enables him to contribute more than he receives.

Facts are transmitted to the urban person when he is on the job. He is given a definition of his task and then is expected to interpret the messages coming in, calculate an optimum response, and then apply effort toward that end. This is very different from the villager who tills the soil, sows, harvests and allocates the output according to traditions that leave him little choice. The urban job even in the poorest cities, characteristically requires much more instruction, many more messages and interpersonal transactions, and much more calculation of trade-offs. A large share of the communications in the city are gauged so as to improve the man, or the team, or the organization, so that any and all of these may be expected to improve their performance. Therefore, the connection between the expansion of the flow of communications and the development of human resources is direct. When substitutions occur it is only because one set of messages has been demonstrated to lead to fewer errors in judgment than another and therefore better performance. In general, the superior instruction, training program, or presentation of data transmits more information per unit of time. Thus, planners should expect that rapid development of human resources will put a heavy strain upon printing plants, telecommunications, tape recording of all kinds, secondary and higher education, libraries, and computation.

Conservation of human resources starts with health policy. It does not help a society if a trained individual is allowed to succumb to epidemics or accidents. Therefore, amazingly complex curative and preventative institutions have evolved whose mission is to reduce the prevalence of ill health. Interestingly enough, close to 99% of the effort that goes into the operation of health institutions is expended upon communications.



Another kind of conservatism is expedited by parts of the educational system. If a man's skills should be rendered obsolete by social or technological change, a large part of what he has already learned can be re-focussed and advanced toward a new skill. Such training programs must be accelerated as development proceeds. They are, of course, a mixture of learning-by-doing and learning-by-listening, with some resort to reading and the presentation of pictures or diagrams.

The truly critical resource, therefore, is the cumulated, codified human experience with Nature, artifacts, and with each other. Observations and memories must be exchanged, so that each man can make decisions with the aid of the wisdom acquired by many predecessors. Repeatedly, we can find ways of evading the increasing scarcity of other resources by drawing upon this body of new observation and recent experience.

Knowledge is treasured by institutions and is clothed in many kinds of images which may now be recorded in such media as print, microfilm, specifications of artifacts, statistics, and even the trained responses of members to queries, challenges, and opportunities, as in medical diagnosis. Urban institutions as a rule possess far more knowledge than rural institutions engaged in providing the same kinds of services, and the modern versions are similarly distinguished from the traditional. There appears to be a relatively stable stock versus flow relationship between knowledge and communication in a given institution that very much resembles the capital-output ratio used by economists for the respective industries. Innovations in communications, when applied to water, energy and human resources, will automatically create opportunities for the accumulation of more knowledge to restore the knowledge-communication ratio to which the respective institutions are accustomed. Thus knowledge is

increasingly committed to electronic versions with rapid retrieval characteristics that are compatible with computers and telecommunications.

This technology alerts us to the existence of a natural resource that has hitherto not been scarce and so has been allocated as a free good--the channels in the electromagnetic spectrum. The pressures to communicate within the modern urban environment have introduced a rapidly increasing number of conflicting claims for channels as well as a new kind of pollution. For example, police calls break into the aircraft channels, while an inadvertent mobile radio transmitter may cause the radio-controlled garage doors in a new suburban tract to begin opening and shutting. Spark gaps on vehicles create radio "static" and television "snow." Some channels must be left unused due to "intermodulation products" very similar to the effects of noisy, dirty industries on adjacent spaces. Thus far the conflicts in the United States, where the use of the spectrum resource has been most extensive, have been resolved by cooperative technical committees on which an estimated 10,000 persons, mostly engineers, have served. However, the problems are now reaching a stage of criticality where management of the resource will require national and international policies to be promulgated, according to the Joint Technical Advisory Committee of the Institute of Electrical and Electronics Engineers (1968).<sup>1</sup>

Fortunately, a wide variety of conservation procedures is known to exist. The public management of the electromagnetic spectrum resource must select those which promise to be the most economical over the long run. The future metropolis threatened with this kind of congestion and pollution will very likely be forced to establish priorities. The most

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<sup>1</sup>Joint Technical Advisory Committee, Spectrum Engineering - The Key to Progress, Institute of Electrical and Electronics Engineering, New York, March, 1968.

important messages will either be given clear channels (not unlike the rights of way for railroads) or be piped through in co-axial cables or a high capacity wave guide (the best analog is a freeway). Costs for the foreseeable future are relatively small unless the competitors for the channels, mainly the military, the telecommunications utilities, the airlines, the vehicular fleets on the surface, the educators, and the aerospace scientists, are irreconcilable. Pollution control for the spectrum need not become even a tenth as expensive as air pollution control in the large cities, but lack of control could be as critical for a metropolis as for any other resource. It would show up as an inability to maintain public order at times of peak demand, as a reduction in capacity to grasp opportunities as quickly as the competition, and as a loss in creative talent in the communications industries.

Therefore, the metropolis that expects to cope with its emergencies, whether small, medium or large, must pay increasing attention to the spectrum resource. It must plan ahead for spectrum utilization in much the same manner as it presently does for water, energy, health and education. As with the other sectors, cities are not free agents in planning the growth of communications, but must negotiate with higher tiers of government as well as with neighbors.

The late 1960's saw the evolution of the beginnings of the "computer utility networks." Altogether perhaps ten billion dollars worth of new value, as measured by the selling price of securities, was created, and during the 1970's it is anticipated that this utility

should increase tenfold more with many installations in Europe, Japan, and Asia complementing those in North America. Huge quantities of data will be assembled in each metropolis concerning commercial transactions, industrial production and quality control information, shipments, traffic, meteorology, and public opinion. Digested information is expected to be transmitted to other metropolises via cables, micro-wave relays and communications satellites. The spectrum resource will bind the economies of the world's metropolises together on a day-to-day, even an hour-to-hour, basis, so that each is enabled to make speedy local adjustments to worldwide trends. Metropolises would then assist each other in their development and adaptation, much as the major regional banks have done for decades. Internally the new utility would lay out a network of cables, eventually wave guides buried in the ground, to reduce the effects of electromagnetic pollution--the products of indiscriminate radiation of radio waves by spark gaps, heating appliances, radar, television sets, etc.

A partially overlapping utility network has been delayed for lack of licensing which affects the dissemination of instructional and cultural material. The cable television (CATV) networks have sprouted first in relatively isolated locales with the initial justification of providing better signals and greater participation in the mass culture. However, the cables have a large unused and uncommitted capacity in them that begs for socio-cultural inventions which would put them to work. Comprehensive cable television networks are expected to be installed in some metropolises soon, and with them a newly accessible

resource which could be put to work in health and safety or in education, if only we had a formula for fitting needs with the supply. Many more channels are available for transmitting programming into the house than are presently used for transmitting commercial and educational programs. The marginal cost of transmission and reception is virtually nil, but the value of the time invested by both senders and receivers is significant. The message must be worth the time of the people involved.

#### Conclusions on the Criticality of the Urban Condition

Large modern cities are very tough. They refuse to die and they recover quickly from grievous injuries. They can be snuffed out and sterilized against future settlement as part of the fortunes of war, should it ever break out in a serious nuclear form, but even besieged cities, such as Saigon once was, retain a vitality that enables them to come back in very short order.

Note also that the accumulation of wastes and general environmental pollution has thus far had an insignificant effect upon the provision of jobs and services. The toxic effects of wastes are not evident despite many assertions to the contrary. It should be remarked, however, that once the migration from rural areas has subsided to a balanced two-way flow, the inter-city flows become highly significant. Abandonment of any metropolis by its intellectuals as a means of escaping a contaminated environment would leave the city virtually incapacitated. Thus, the past record for surviving threats is not a very trustworthy predictor for the future. The organizational competences on hand must be mobilized for meeting the unprecedented challenges.

Cities seem to be most vulnerable to water shortages, and become increasingly so as they expand in size. The solution appears to lie in the adoption of multiple technologies applied to the development of sources, to the addition of extra distribution systems for different water qualities, and to emphasis upon reprocessing or upgrading of waste effluents. This differentiation of both supply and demand will require ten or a hundredfold increase in communications in order to make reasonable decisions.

Some cities may be starved of energy because they are forced to import virtually all of it. Energy is saved by careful calculation and programming. Such saving is already accomplished for electrical power production in most regions, within the terms of reference employed by the power utilities, somewhere quite close to the optimum achievable, but the possibilities for operating beyond the present rules, such as "load spreading," could add perhaps 20 per cent to their efficiency. Finding substitutes for automobile trips promises much larger energy savings but again efficient use of mini-bus or mass transit systems on a round-the-clock basis is implied. Elaborate communications systems are needed to connect the user with the best ride to his destination, and it is also possible that in the more distant future, even if it is not likely soon, a flow of messages would make many energy-consuming trips unnecessary.

Cities have the reputation as well for stirring up revolutions which later can harm their own functions. The Red Guards may have had this effect upon Chinese cities, but worldwide evidence confirming this

proposition is not convincing. In any case, the construction of legitimate, representative governments committed to the rule of law is clearly advanced by both the urbanization process itself and by the communications made possible by the increased investments in human resources allowed by greater population densities, according to the recent literature on political development.

Future security of a metropolis against injury therefore almost always depends upon communications, education, negotiation between interest groups, calculation of costs and benefits, and drawing upon an accumulating stock of knowledge. Another resource, that of the electromagnetic spectrum, will be drawn upon by the communications technology. Although no disastrous waste is yet evident, there are many gross inconsistencies and the policies for administering this resource, which could in the long run become the most critical of all. At present, hardly a metropolis exists that is alert to the significance the electromagnetic spectrum and is taking measures to prevent its pollution. Cities will probably have to suffer a bit before they discover which are the crucial resources, because no amount of consultant's reports is likely to persuade them as completely as experience. Fortunately, cities are becoming so tightly connected that the difficulties of the few will have an effect upon the policies of the remainder.

TABLE TWOMETROPOLITAN CRISES IN THE 1960's

A Classified List of Threats to Functions  
(includes only million size metropolitan regions)

Water Hazards

Hong Kong, 1961; Cut off from reservoir  
in China  
Hamburg, 1962; North Sea flood tides  
Bombay, 1963; Drought  
New York, 1963-5; Long drought  
Madras, 1969; Reservoir failure  
Calcutta, 1969; Works breakdown

Institutional Loss or Collapse

New Orleans, 1960; Schools shut down  
Rio de Janeiro, 1960; Government moves  
out  
Hong Kong, 1960; Refugees overwhelm  
housing  
Hong Kong, 1962; Refugees overwhelm  
housing  
Alexandria, 1962; Loss of summer capital  
Atlanta, 1962; Elite die in air crash  
St. Louis, 1962; Metro. government  
rejected  
New York, 1966; Garbage and transit  
strike  
Calcutta, 1966; University strikes  
Singapore, 1966; U.K. Navy leaves  
San Francisco, 1967; Council of gov-  
ernments funds stolen  
Tokyo, 1968; Universities shut down  
Rome, 1969; Strikes of service workers

Energy Failures

New York, 1965; Power blackout  
Beograd, 1969; Hydroelectric shut-  
down threat

Accidents and Natural Events

Tashkent, 1966; Earthquake

Revolution and Rebellion

Dallas, 1963; Kennedy assassination  
Singapore, 1965; Separated from  
hinterland  
Los Angeles, 1965; Watts "rebellion"  
Jakarta, 1966; Assassination and  
genocide  
Cleveland, 1966; Hough riots  
Hong Kong, 1966; Maoist riots  
Wuhan, 1968; Red Guard battles  
Washington, 1968; Riots and looting  
Paris, 1968; Student uprising and  
general strike

War

Berlin, 1961; A wall is built  
Lahore, 1965; Tank invasion threat  
Prague, 1967; Russian takeover  
Saigon, 1968; Tet offensive

Note: The identifying descriptor serves only to focus attention on a complex set of events that is believed to have been associated with crisis behavior in million-size cities and has been reported in international news services to some degree.



### III. Insights into Pollution

There are those who revere the eco-system, and wish to maintain its unity. This dedicated minority finds itself fighting threats that are given three different labels. The destruction of a resource in connection with use is depletion. It applies most often to minerals but it is also a term used for such diverse resource types as forests and fish. The proper response is the development of substitutes from resources in greater supply, as already discussed. Negligent, unconcerned, improvident use results in waste. Slothfulness in obtaining and using recent information is usually found around the responsible decision makers. The answer lies in the improvement of management. However, the corruption and contamination of resources is called pollution, an even less neutral term. These are not mutually exclusive categories, so it is quite possible for a single act to be depleting, wasteful, and polluting at the same time. The three words actually imply different degrees of condemnation at the present time instead of different policies of exploitation.

The facts about pollution in all its various forms are now remarkably well disseminated. Any attempt to review them here would run a great risk of restating the obvious, which is the last thing this study hopes to do. If the reader is not confident he has encountered the essential facts he can acquire them painlessly by reading George R. Stewart's illustrated prolegomenon on the "effluent society" entitled Not So Rich As You Think [1968]. It reports quite comprehensively on the situation in America as of the year 1967; the issues requiring policy

determination have changed very little since then. Although a careful recorder of the underlying technology of waste-making and waste-spreading, Stewart is also an established master of the English language. Thus it is not surprising that he has caught the flavor of the hyperbole and overkill employed by the extreme conservationists so as to generate concern for resource degradation on the part of the public.

Pollution causes scientists and engineers great anguish, as they become more deeply involved, because the definitions are not anchored, but keep drifting. Pollution is a cultural concept, and implies a commonly held belief system. Inevitably, the operational meaning is elusive. About the time engineers are able to concur on a technical standard for assessing the quality of a resource, thereby establishing whether it is being degraded by men, the elites in the society shift emphasis and claim they wish to be even more discriminating than before or they extend demands for prohibition in some new direction. Measurements of the thresholds for impurity or befouling are obsolete as soon as published because some vocal sub-culture is impelled to draw the line between clean and dirty differently and there seems to be no adequate impartial tests for determining who is right on the basis of the empirical evidence. Conversely, the policies for purification or anti-pollution are automatically categorized as "conservation of natural resources." The emotions of Nature worshippers are readily aroused; they will decry the actions of others who pollute the environment. Society should prohibit the offending behavior and impose strong penalties upon the culprits. Anti-pollution technologists have learned to tread warily, lest they stir up violent bursts of imprecations. It is

now virtually impossible to find a more controversial domain for the application of science.

Perhaps the most patient and informed view of the problem, including the extent to which a technological or remedial solution existed, was provided by a Subcommittee on Environmental Improvement of the Committee on Chemistry and Public Affairs of the American Chemical Society, chaired by Lloyd M. Cooke. Their report was published under the title Cleaning Our Environment: The Chemical Basis for Action (Washington: American Chemical Society, 1969). In it one finds the illuminating statement, for example, that "more detailed information is available on pesticide residues in the environment than for most other contaminants...." (p. 19). Indeed the concern about DDT, 2,4-D, and other members of that group of synthetics is attributable to a large degree to the excellence of the analytical methods for determining minute amounts of such pesticides. If equally fine methods were available (and used) for detecting small quantities of other known toxins and poisons, natural and synthetic, the portion of our population disturbed about pollution would be driven to complete distraction, because there must be many hundreds of agents present in the range of 0.1% to 10% of the level dangerous for wildlife or humans which could be concentrated locally to produce noticeable harm.

The chemists systematically divided the problem by the medium threatened--air, water, land, and ecosystem. They take responsibility for the full range of facts, chemical and otherwise, and emphasize the need for data primarily about long-lived substances. Their recommendations are directed at the means of efficiently acquiring information that would provide the basis for action, whether it be standards-setting, purchase of equipment, legal injunction, or statutory control. They

try to remain safer in the face of an excitable public, much of it made up of academics and other professionals.

### The Semantics of Pollution

Why should there be such heated reactions? Tracing the sources of the word pollution is itself already highly illuminating. The origins of contemporary terms and their shifts in meaning over time often reveal the bases for profound disagreements.

Pollution is the violation of a taboo; thus the idea of pollution is much older than the concept of a city. Primitive man was already making distinctions between the natural and supernatural, and taboos ordinarily reflected natural situations or conditions to be avoided. Taboos were often extended into the ambiguous zone in between the natural and supernatural, whereupon pollution and desecration could not be differentiated. The Greek word for "pollute" is literally translated "profane, contaminate"; the noun is miasma, one meaning of which has been continued to the present time. In the Hebrew meaning associations with scum are indicated in addition to those incorporated by the Greek. are all values which, when violated, stir up strong denunciations and retributions.

The etymology of the present English term is straightforward since it stems from the Latin noun pollutionem--defilement. A man, a place, or a piece of property could have been made unclean through physical befouling or through some immoral act. It is a term used by the educated classes for formal breaches in conduct, while the masses developed their own language around one of the famous four-letter Anglo-Saxon words--dirt. Mary Douglas, in her book on Purity and Danger (1966), demonstrates

that for dirt to exist there must be an idea of system that applies to the perceived environment. When a thing is dirty it is offensive and should not be touched. Tools or instruments are to be used in cleaning or tidying up. Small children are taught these rules of dirt-avoidance from the time of toilet training onward. The rules may later be extended to contact by other races or sexes, so that color bars and caste barriers are maintained by pollution rules.

Of course no organisms, not even pathogenic bacteria, can survive as a population when living in their own accumulated wastes. Some device of nature or some acquired reflex is needed either to flush away the wastes or to leave them behind for recycling. Prehistoric man came closest to violating this generalization because his habitations were found strewn with litter. For a long time the masses of gnawed bones in Pleistocene caves were attributed to the predatory success of hyenas, since some hyena bones were found but none from men. However recent studies of the lair-keeping standards of hyenas show that they tolerate no bones at all in the cave, thus leaving us to conclude that all those caves were temporary residences of early man. Therefore what we now regard as pollution came to cities at the time of their founding, but the citizens no doubt felt that the presence of other peoples and their property was the predominant source of pollution. Segregation into "quarters" and even tinier enclaves was almost universal; separation of household activities minimized polluting contacts.

The slops and animal droppings were carried through the dung gate to heaps just outside the city wall, if anything was done at all. The exceptions that were found, as at Knossos on Crete, are most remarkable for their rarity.

By the time of the Romans, however, a transformation had occurred. An abundance of slaves had reduced fears of defilement by barbarians and simultaneously made available a huge labor force. Personal cleanliness became important. Pure water was introduced to the fountains of the great cities with aqueducts, and the disposition of waste to the downstream side called for major sewer works. Citizens developed a taboo against filth at the same time that the taboos against barbarians were being dissipated. Thereafter Dante's *Inferno* provides us with an imaginative collection of tortures-by-pollution of the milieux prepared for lost souls.

Taboos involving elimination were greatly strengthened over the past two or three generations. The displacement of the garderobe, the two-hole privy, and the chamber pots by the modern bathroom caused elimination to be carried out increasingly behind locked doors and therefore built up a taboo on the sight, sound, smell, and taint of human excretion. This taboo has even been extended to the reuse of water after sewage treatment regardless of its chemical analysis. Virtually all American communities that have had opportunities to recycle their waste-water found their projects halted by guardians of propriety. The veto groups were either made up of vociferous local citizens or of bureaucrats who had come to understand the risks generated by sensitivities found frequently in the elite class.

Critical tests that determine what is polluted depend increasingly upon chemical and microbiological analysis, but they must also fit within rules of purity and of conduct designated by an educated class. Civilized taboos are more systematic and less arbitrary than the primitive, but they remain taboos nevertheless.

The arbitrary character of the taboos maintained by an urban society is perhaps best exposed by an application of the semantic dichotomy dirty: clean. Well informed residents should be asked to assign one or the other to a wide range of perceptions in the cityscape. Surprising degrees of consensus can be obtained regarding many urban contexts and locations. Many more beliefs are virtually unanimous among people of the same social class and ethnic origin. Convictions about pollution are maintained over the long run because institutions bring pressure to bear upon deviant individuals. The punishments applied to acts of pollution are used to enforce conformity; the earliest memories of children are very frequently recollections of being scolded or spanked for willfully dirtying the environment or the food the family was expecting to eat. Each punishment more specifically defined the meaning of dirt for the child, and he passed this information on to siblings and playmates. Thus even in a rational society concepts of dirt are transmitted at a pre-rational stage and so maintained in the culture more strictly than intended.

#### The Health Factor

Some taboos may have sufficient foundation in fact to promote the survival of the group that holds to such rules. They are the superstitions that contain grains of truth. Thus a "survival of the fittest" process should come into being for taboos. The conditions for selection must explain the existing rules for dealing with the contamination of resources as well as they contribute to the survival of the group. Good taboos should eventually drive out the bad. The pollution taboos of interest to the health sciences are the best examples, because they may

prevent the epidemics that weed out the population. Taboos affecting health are particularly important to cities because urban environments had excessively high death rates due to disease from the time history began to be written until the nineteenth century. Those who survived the endemic diseases, such as malaria and dysentery, succumbed to periodic outbreaks of "the plagues." Wherever people had become tightly packed in their living arrangements tuberculosis was particularly deadly. When cities warred against each other health was as often the factor determining the winner as the quality of the weapons with which they fought. The right mix of rules provided a strong defensive capability at the time of seige, but even the healthiest urban societies retained practices that were later discovered to be wasteful, harmful, and pernicious. A selection process based upon the "survival of the fittest" criterion cannot select out from a list of hundreds of specific taboos all those that are disadvantageous, and it has even less likelihood of generating new health-producing prohibitions. This capability came onto the scene only after adoption of the scientific method for making policy regarding health.

An important collection of taboos associated with cleanliness were accorded much more respect as a result of the propagation of the "germ theory of disease." Here was a body of biological principles which had already yielded some spectacular results and promised much more. They introduced a series of operations for discovering what should be considered unclean; with the aid of microscope and some agar plates one could trace direct connections between contaminated food, water, air, and artifacts and the specific disease contracted.



The conclusion that all illness was caused by germs was a natural simplification and a program for the control of the environment for purposes of health was a natural corollary. Hygiene was taught in the schools and teachers took on the task of proscribing what was dirty instead of depending upon the folklore transmitted around the household. The results, as measured by numbers of human survivors, have been spectacular, and a very high proportion of the incidence of illnesses and deaths attributed to pathological organisms has been eliminated from urban populations, even in the poorest parts of the world.

Sometimes the effects of successful public health measures led indirectly to some rather puzzling setbacks. Thus a general prevention of infection at an early age is discovered to lead, in a small fraction of instances, to a contraction of an endemic disease at a later age with more injurious outcomes. Mumps and poliomyelitis are believed to belong in this category, while infectious hepatitis may well be another. These epidemics are small in scale, but frequently crippling in their intensity. They are now visited very heavily upon a clean-living population. The spread is normally quelled by invoking one or more of the immunological interventions, but the cost per injury prevented has by now reached a high figure.

The art of detecting poisons, whether plant or mineral, also increased rapidly with the advent of science. More antidotes were found, and the modes of action of both toxin and anti-toxin were elucidated. However, simultaneously, modern industry began to produce a large number of new poisons. The specialty of industrial hygiene thereupon came into being; its principal task was to protect the workers who were exposed to a variety of new hazards. The jobs of these practitioners

overlapped those engaged in preventing epidemics, and an echelon of specialists in sanitation and industrial hygiene was created to protect the urban public.

One of the most peculiar poisons was extracted from uranium ores and used to illuminate the dials of watches. The delayed effects of radioactivity slowed down a recognition of the hazards so that they began to be understood only in the 1920's. Meanwhile physicists demonstrated the parallel biological effects of X-rays and cosmic rays. Geneticists discovered random chromosome breakage. Thus pollution by radiation and radioactive elements came to be recognized even before World War II, but it remained the province of a few hundred people who possessed the knowledge. Nuclear weapons testing followed by nuclear power generation have pushed radiation pollution into the forefront of public concerns. Extensive discussion of the effects upon human fertility and upon the production of mutations in future generations aroused extra fears, particularly among elite groups. Rumors about radioactive pollution induce strong feelings of hysteria, in addition to the nausea and outrage caused by other kinds of pollution. Threats from radioactivity are very serious for the present generation, since concentrations of pollutants that cause small losses (as compared to those that occur repeatedly due to preventable accidents and conflicts) could trigger a panic which very likely would entail much larger loss. The unease that provides the raw stuff from which panics are made comes from the repressed hysteria. Thus more attention is paid, and more money spent, to prevent catastrophes from radiation than other threats of equal magnitude but more ordinary causes.

Threats to health in an urban society are as serious as the use of violence is a threat to personal safety. Therefore public health officers have been granted police powers which can be used to intervene at the source of the threat or to operate upon its vector. They are allowed to use coercion in the public interest. However, in order to remain legitimate the public health officers must have presumptive evidence of a true threat. They need symptoms, signals, indicators, criteria, and justifications, preferably in some readily comprehended, systematic framework--not a manual of prohibitions. For such a system they look to science to determine the threshold of environmental impurity at which humans are harmed, and to technology for instruments sensitive enough to detect environmental changes that cross the threshold.

The science of man is woefully incomplete. It has been evident for some time that the average, or standard, man so often invoked in arguments about man-environment interactions should not be used in designating thresholds for intervention. Some people are far more sensitive than others to specific pollutants. Should we set the indicator for action when five per cent are noticeably affected? One per cent? One per thousand? Note that as the proportion is reduced the cost of collecting data pertinent to risk increases, often exponentially so that finding out could absorb all the professional talent and funds otherwise available for intervention. Thus there will always be a significant fraction who may be affected by a given level of pollution but no one will ever know for sure which are the individuals or where they may live, because their cases lie beyond our ability to detect.

Deciding where to set the threshold or minimum standard is a joint technical-political decision. Much depends also upon which social class or organized group is likely to be affected, because a few are far more vociferous than the main body. The decision on setting standards is also made by committees of professionals who belong to the same social class, some of whom often play leading roles in the groups that take positions and speak out on man-and-environment matters. It is worthwhile noting that the lower-middle income people and the poor are almost universally left out of the politics of setting minimum standards.

#### The Esthetic Factor

Much of what is called pollution merely offends the senses. The aromas of baking bread or roasting coffee are quite penetrating, but acceptable, while the smell of cooking soap or varnish is called an intolerable stench. Water is clean when trout and salmon live and reproduce in it but is impure when occupied by catfish, eels, and "trash fish." Building materials incorporated in a house are part of the existing order of things, but the same materials left over on the lot have become a solid waste problem. The concept of pollution is sometimes even extended to cover the garish neon signs that hide the cityscape when traversing the avenues by automobile. Similarly a rolling automobile is accorded respect, but one that no longer moves is classified as junk, and millions of them still occupy the back lots. In all of these instances an idealized conception of environmental order has been violated.

The general concern for renewing the esthetic features of the urban environment introduces a fundamental insight: A concept of proper

order underlies all statements about pollution. Even the foregoing assessment of poisons thrown out into the environment was forced to focus upon health--bodily order--risks for anyone unfortunate enough to be exposed. Health remains a vague term, nevertheless more consensus has been achieved regarding that kind of order than can be applied to the external environment. Disruptions of order in personal grooming, the household, the neighborhood, the central business district, the park, or the wilderness are all claimed to be polluting. But what are the determinants of proper order?

A question like this is grist for the philosopher's mill. Kuntz recently published a twenty-sided reassessment entitled The Concept of Order, so it has become easier to find well-digested viewpoints. Environmental order for Aristotle meant tilled fields outside the city walls, clear sparkling spring water, freedom from the miasma of nearby swamps and cesspools, cobbled streets with prospects opening toward temples and monuments, and control over the delinquent resident, whether his intent was to rob, add to the graffiti, or merely to drop debris. For Thomas Aquinas order was hierarchical; a proper life style existed for each level in the hierarchy, and each life style made complementary demands upon the environment. For Europe of the nineteenth century it meant formal gardens, gridded street patterns, and allusions to the classics by all forms of imposed imagery, particularly architecture, grand scale art, and uniforms. The antithesis of order was provided by factories, railroads, slums, deforestation, and frontiers. Since then change has come rapidly, with many of the institutional sources of disorder and turmoil becoming pillars of the new order and those pillars overturned in favor of more abstract concepts.

The most comprehensive theory of environmental order treats the environment as a message that people interpret sequentially on the basis of what they recall from past experiences. This much of Marshall McLuhan most investigators can accept. Thus contacts with the environment are similar to reading a body of prose or listening to a musical composition. If the message is full of cliches and repetitions it can have order, though at a low level, and it would be dull. Soon it would fail to gain the attention of the population. If the message has too many surprises and unfamiliar patterns, it induces fatigue and is again given too little attention. The condition of optimal environmental order--the golden mean--lies somewhere in between.

One's education and experience determine what transmission rate from the environment is deemed to be proper. Low levels of education tend to embrace standards adopted by elites in the nineteenth century because by now they have become familiar; people with high levels of education can often infer order even in a wilderness, and so will treat anything that disturbs the wilderness as a pollutant. In the city this modern intellectual elite will demand a wide repertory of synthetic images-in-context, as well as attention to detail or "finish," so that the edges make well-defined patterns. There is also a demand for "disciplined ambiguity"! Information transmitted by the environment for these two extremes in sophistication should be proportionally as great in rate as it is in reading material, drama, and the interpersonal transactions in the family when its members are at home. The mass of the population lies between these two extremes and has acquired a broad distribution of values reflecting propriety in environment. Families seeking homes in the suburbs

spend a great deal of effort in an effort to match their taste for order with the environments presented.

In an affluent society it is much more feasible for a person or group to construct a private environment. Often this private synthesis will revolve around a common avocation, such as gardening, raising pets, or yachting. Then certain specific pollutants, usually created by the wastes of millions of other people around them, are raised to a level of a threat to that style of life. Such threats are fought vigorously and tirelessly, often to the last dollar in the bank account. Thus the subdivision of the metropolis into communities containing citizens who have made strong commitments to the site or into neighborhoods and households, creates a multiplicity of proprietries in environmental order and sets the stage for a bitter conflict.

#### Consequences for Policy

The import of this excursion into the prohibitions and the non-material values attached to resources, waste, and pollution is now clear. Hard, physical facts are less influential in changing policy than attitudes and sentiments. Beliefs held tenaciously by educated people represent the greatest hurdles to be overcome before major programs for efficient use of resources can be put into operation. The technologies for striking improvements in conservation are at hand, and neither peasants nor the urban poor--so often the stumbling block when hands must be redirected and retrained--are in position to prevent their application. However the beliefs of one splinter or another of the educated classes may be violated by taking such action. These tiny minorities usually do not have the power to promote alternative changes but they are able

to confuse the choices enough in a democratic society so as to effect a practical veto.

Case histories of projects intended to conserve resources are beginning to sound repetitious. Engineers consciously endeavoring to minimize the likelihood of air pollution from the stacks of a large power plant seek locations away from human settlement, but then discover to their surprise that each economical site is excluded. The lovers of wild fowl, or the defenders of a species of rare molluscs, whose habitats would be disturbed by the warm effluents, or the viewers of a "mountain" that would take on an unnatural shape, will demand public hearings and legislative intervention. Even the string of pylons that conducts the power to the city have their ills. Those who would make a major effort to reduce river pollution by creating a parallel ditch with a treatment plant for agricultural and industrial wastes at its terminus often find no neighbors on the estuary willing to accept the outlet. A continuing crusade by urban vacationers to save forests from being cut by timbermen slowly builds up the risk of a fire storm that would cause loss of life and property on the part of local inhabitants, and perhaps few of the lingering vacationers themselves. Thus conservation is rapidly becoming its own worst enemy.

Virtually every metropolis is able to save much valuable human time and a few lives by reducing congestion in the flight patterns of aircraft. Normally this is done by building a new airport or expanding an old one, but nowadays veto groups arise on every side, two or three at a time. New people may be awakened by the noise of low flying aircraft, or the estuary wildlife will be disturbed, etc. Such interest



groups demand preservation of the environments that are precious to them at the expense of a much larger portion of the public.

One major source of this frustration lies in the educational reforms of a generation ago. Soil conservation, forest management, the preservation of threatened species, and national park development were doctrines that spread from elite centers to most colleges and from there to many high schools with academic curricula. Those values gelled and were gradually elaborated into local political platforms and then into bureaucratic principles. They have been accepted much too blindly.

Progressivism, scientism, and conservation were inseparable components of the middle class culture conveyed to the present older generation. These values have produced a number of paradoxes. Many hunters exposed to these lessons remained convinced that it was improper to shoot does during the season, even when it was reported that 10-40% of the deer population regularly died of starvation in late winter. Quite a few college graduates resisted the cutting of pulpwood timber, even when the new growth was already exceeding prospective consumption. Quite a few people advocated complicated programs for keeping the nutrients in the soil, even though fertilizers with soil nutrient replacements could be used at far less cost. Sites of parks were deemed to have been dedicated in perpetuity, and could not be traded off to obtain superior sites for public recreation.

More than anything else, perhaps, the suspicions of the early conservationists regarding either the avaricious timber and mining barons or the tradition-minded farmers were retained, even though the prototypes disappeared from the scene. Indefinite adversaries called "them" or "they," became the objects of deep suspicion. Therefore diversions of attention to the tradeoffs that are possible are rejected emphatically

as the "camel's nose that was let into the tent" or the "inch that would allow them to take a mile." As always, dogma has been reinforced by aphorism.

The literati have taken up a more systematic ecological perspective. A careful review of the words they choose to apply to the current situation often reveals a preference for terms from theology. People and governments commit sins against Nature. It comes as no surprise then that neo-Calvinist stewardship for the environment constitutes ideal behavior. In this catechism tidiness is godliness. True believers exhibit a compulsion to isolate primitive areas and wildernesses, protecting them from insult by the humans that wish to use them. A typical act of devotion is to write a letter expressing outrage to the New York Times, Harpers, Time, Science, or the local news sheet. The more repetitive ritual, equivalent to prayer, is writing to one's congressman. One's vacations are spent making pilgrimages to holy places. The Sierra Club dramatically increased its membership when it resorted to the organizing techniques of the early Christians.

As a religion the literate variety of conservationism is one of the most innocuous to appear on the scene. The devils are of this world--litterbugs, pesticide sprayers, and oil slickers are typical--and their behavior can be curbed by appeals to authority (Science is coequal with Government), by litigation, and by education. Unfortunately, as with all other religions before it, schism continues to rear its ugly visage. The mildness of the ideology is revealed by the observation that heretics are not burned or shot (as, for example, Malcolm X who deviated from the true path as a Black Muslim), but merely subjected to character assassination.

Therefore, if an educated person is predisposed to seek a faith, the worship of the unity of the eco-system is perhaps the least harmful to come along.

Religions cause harm by restricting freedom of choice in the society at large. They do this not only because they concentrate upon actions of the moment which close out many options in the future, as an economist would diagnose, but they specify many other sins which merely have the potential for producing pleasure or convenience. (Thou shalt not construct a highway or transport electric power through a wilderness.) Moreover the injunctions are imposed not only upon the believers, but upon the community as a whole. The degree of commitment to a faith is measured by the number and variety of pleasures relinquished by the faithful plus the morality that has been imposed upon others. The difference between religious dogma and the taboos introduced earlier is that dogma is fixed and unyielding, uncompromisable and non-negotiable, while taboos can be modified, transferred, and even extinguished. Thus the nature-worshipping literati may on some occasions inflict measurable losses upon others.

An illuminating example may be drawn from recent events in Northern California. In the late 1950's a major Save-the-Bay crusade was organized among the top professionals and businessmen in the communities surrounding the San Francisco Bay. The major threats were pollution of water and air, and the loss of the marshes and tidal flats to apartments, factories, docks, and airports after receiving the solid waste from the cities. A temporary Bay Conservation and Development Commission was formed to study the problem and recommend action. It was found that much of the pollution would be under control as soon as

treatment plants in various stages of construction came into operation, but that encroachment upon the Bay Shore would rise to unprecedented dimensions. It could be stopped, however, if suitable legislation were enacted. This was deemed to be a good and worthy objective, with no further analysis required.

However, the urban ecology of North American cities leads to the settlement of ghettos in low-lying areas. Thus seven of the eight Negro communities, and two of the three Latin settlements, immediately adjoin the Bay. They typically exhibit unusual concentrations of unemployment. The principal entry into high paying jobs for the young men happens to be through the construction industry and its suppliers, but if all construction around the edge of the Bay is halted, the growth is deflected to the periphery where new immigrants and migratory workers are likely to get the jobs. Ghettos have poor transportation connections to the suburbs. Already the unemployment level in these communities of blacks and browns is much higher than in any other part of the metropolis. Thus saving-the-Bay, as conceived by the purists, will benefit those with "view" lots, yachts, and interests in estuarine wildlife, at the expense of the future of segments of the population least able to pay and communities that remain undefended against indirect attacks upon their interests.

A fair resolution of the issue would be to tax the people whose esthetics, beliefs, and taboos would be offended. The rate should be enough to transport the blacks and the browns to the jobs in the growing suburbs. However, that operation would encounter bitter resistance from the suburbanites themselves since a large proportion have recently fled to those communities to avoid racial integration in the central

city. One suspects also that the privileged group would regard the size of such a special tax as intolerably high; they would vastly prefer to have it undertaken by the public at large, even if a majority of the public does not share the benefits.

An alternative, of course, is to compromise--develop a plan that would serve as many different life styles and specialized publics as possible, including the construction of perhaps 20,000 units of waterfront apartments and moorings for thousands of houseboats in designated areas. The plan should be kept open enough to take advantage of new opportunities when they arise. Services to any specialized group should never be subsidized unless tradeoffs have been worked out with many other groups. If at all possible individuals that benefit extraordinarily from the public development of the shorelands should pay at least a full share of the cost to the operating administration; if the resource is scarce it should go to the highest bidder, public or private, who would not degrade the values obtained by others. The remaining resources are regarded as cheap and are allowed to be used opportunistically. Leases on land should be kept relatively short during the period of rapid development. These are a few of the relevant principles that are well-known to planners, in theory at least, but are not easy to apply. The primary reason for their difficulties currently is that compromise for the true believer is akin to the crime of treason.

The preceding arguments regarding the wastefulness of ideology have been marshalled with as little hedging as possible. Concrete instances were repeatedly introduced, but detailed proof was not supplied. These arguments and the inferences to which they lead us were constructed

to follow contemporary political theory as summed up by Sartori in his "Politics, Ideology, and Belief Systems" (American Political Science Review 63, June 1969, 398-411). He considers particularly the richly informed belief systems that are held by elite publics and have the special properties of being self-constraining as well as quasi-logical--such characteristics were described more colorfully above in the case of the literati who acquired a deep reverence for Nature.

In the other corner of Sartori's matrix is a pragmatic elite, represented above by the welfare-oriented planners. It can be demonstrated by the theory that when these two groups differ on several public policies a strong affect-laden conflict will occur. Says Sartori, "The two mentalities simply do not fit: their very logic, their Gestalten, are different. Each belief group is inevitably prompted to project its own forma mentis on the opposing group. A blind game results, in which misinterpretation, misperception, frustration, and a spiral of distrust play the major roles." Much to the bewilderment of the external observer, the logic of self-interest no longer suffices to explain political actions. This is a troubled prospect that a wise man wishes to avoid.

The best hope, it seems now, is that the newly evolved ideologies will progress as social movements. A number of the major tenets of the belief system may be expected to lose their centrality and move to the periphery of collective attention. Then the believers may only "satisfice" with respect to these principles; they are ready to consider compromises. Moreover, conservation-biased elites read widely and discuss the contradictions that arise in the content of the messages reaching them. An accumulation of doubts leads eventually to schism, whereupon, after a lag, doubt

is spread more widely. Therefore a strategy can be prepared for introducing rationality, based upon verifiable facts and calculations, that would postpone confrontation and avoid destructive conflict: Maximal effort would be allocated to identifying the paradoxes and contradictions. Each instance should be publicized in the media reaching the literati. Fortunately this is not difficult in North America because their formula for newsworthiness rates inconsistencies as being highly reportable. Instances of "censorship" of embarrassing facts are more often than not indications of clumsiness in presentation rather than closure of the communications system in such a way as to preserve closed minds.

At a later date, after a substantial erosion of the faith has occurred, the economical, resource-conserving reform can be proposed. As will be shown later, the earliest formulations must be adopted in resource-poor developing countries due to scarcity. It may then be possible to elaborate a more sophisticated version for life styles prevalent in Europe and North America.

#### IV. The Differentiation of Life Styles

The idea of a "life style" is a concept still in the process of crystallizing. Ordinarily, its introduction into a planning-oriented analysis of urban development would be resisted as being too vague, yet the exceedingly difficult decisions about what to do to halt pollution and waste seem to revolve around the particular human values crucial to styles of life. A pollutant is a man-made threat to life style, while waste is most often an inefficiency in resource use concomitant to a life style.

The term has been used since about 1965 in contexts where the intent to evade scientific and other critical analysis was evident. Authors wished to rest their case upon softer arguments. That situation needs to be changed over the next few years, so that reproducible data can be collected that is of a kind that will aid us in proposing policies that would extract more value from the remaining resources.

Life style has acquired a meaning that is best portrayed by reflecting upon its range of characteristics. In congested urban regions pace and mobility are significant. Reliance upon a given depth of interaction with others is of supreme importance. Each life style will put great store upon special "peaks of experience," although a few will seek serenity--the absence of peaks altogether. Each will establish dependency relationships with purely cultural artifacts, sites, structures, and kits of tools. A life style is usually highly dependent upon one of the communications media, and may well reject a number of other media because they presently carry little relevant information. Perhaps most



explicit of all is the imagery employed, whether as language, art, or ritual, a given style from all the others.

A life style in this more precise sense can be said to apply to individual behavior, to a coordinated group, or to a small sub-culture. The full set of life styles would constitute a comprehensive description of the "pluralism" of the city, the central characteristic of urbanism emphasized by all social scientists.

All the foregoing remains mystifying until we specify some good prototypes among life styles and some examples of what it should not be imputed to mean. The surfers of Southern California offer a good case. Their days and their weekends are determined by the degree to which the sea is "up," and where the waves might be best. The community activists, with their petitions, telephone calls, and committee meetings form another group that is much more diverse but as easily identified. The systems engineers with their characteristic "Syspeech," blue-sky proposals, gadgeteering, and attention to science fiction make up another group in the same part of the country. These are far more explicit than the cliché about the bluff, informal, auto-oriented, smog-breathing style of the Angeleno householder committed to "community control" that journalists employ. The latter says virtually nothing useful about preferred adjustments in public policies, plans, or urban designs.

Similarly, the urbane, theater-going, concert-sponsoring socialite can be shown to partake of a readily differentiated life style, but "suburbanite" is much too vague a term. The laboratory investigators have created a particular style for themselves, but "student" and "academic" are so diffuse that they should be reserved for large sub-cultures. It is, of course, possible for people to be so common, bland, and

undistinguishable that they cannot be said to have adopted a style at all, but the residue left after all the others have been separated is sufficiently small that it may itself be characterized as "the style of the ultra-ordinary man."

Many city dwellers lead schizoid lives and oscillate between two or more life styles. Unless all of these are suited to the same temperament and rarely overlap, a considerable amount of stress will be induced as a consequence of their interference. The variable of temperament was studied systematically by the philosopher Charles W. Morris. He was interested in "paths of life" and "varieties of human value" that were relatively fixed in the individual over long periods of time. When a life style can be freely selected, as is typically the case in the more affluent cities, temperament acts as a strong bias in the choices. The studies that Morris made reveal a crucial set of factors involved in the choice of life style.

The interest Morris had in alternative paths of life was originally stimulated by the differences between foreign students arriving at the International House of Chicago as revealed by a depth interview. What did they want out of life? Why were so many of them deeply disturbed by the pace and the waste of American metropolitan civilization? Morris proceeded to organize his interviews by describing thirteen paths of life as distinct from each other as possible. One paragraph was devoted to each, expressing what is most highly valued and would be approached with enthusiasm when present in the environment, along with a description of conditions that were to be avoided. Persons generally in the 20-35 year bracket would read each of the thirteen paragraphs and choose the "best for himself," the "best alternative," and the most intolerable

of all the paths described. In this way the mobile elites of the world came to his door and expressed themselves regarding personal preferences. It was interesting to note that even at that time (the onset of World War II) Americans strongly preferred an open-minded, uncommitted, pragmatic, experimental life, but there were simultaneously a significant number clustered in seminaries, monasteries, and enclaves who found such a life intolerable.

Morris then undertook to review history and the classics in order to discover the flowering of the respective outlooks on life. A number of elegant proposals were derived regarding the Appollonian, Promethean, and Dionysian approaches to behavior. Meanwhile, students from Chicago, upon returning to their parts of the world, translated the thirteen paths into the local language and relayed the responses back to Chicago. As data collected his colleagues challenged him to become an empirical social scientist and digest all that new information.

The outcome of the data reduction was most revealing. It clearly destroyed the finest deductions arrived at through classical studies, leaving only a lower level set of generalizations. When a factor analysis was performed, three dimensions were found in the value cluster actually held by people. Also there seemed to be a progression in the paths preferred, perhaps even in the same person, as one moves from simple environments required to achieve the preferred way of life to the complex urban, and also a shift that occurred in response to accelerated social change.

Curiously, this work of Morris has not been extended to social technology. Personnel specialists, for example, have not incorporated his techniques into routine tests. One source of continuing impact is

through David Riesman's major study published as The Lonely Crowd and Faces in the Crowd. The latter republished the seven paths of life found to be most relevant for Americans. Riesman's books have been influential in the training of psychiatrists and clinical psychologists, but unfortunately they were completed before Morris had demolished his own greatest conceptions. The present motivation theorists do not cite this work, perhaps because it has been out of the mainstreams of psychology.

Another set of experiments, similarly constructed, isolated an environmental component. A variety of photos of houses on their lots with landscaping in full view were shown to populations. The stated preferences reveal that in Chicago of the early 1960's seven prototypes were sufficient to include the tastes of virtually the whole population. The quality of the individual photos did not significantly influence choice. Features such as greenery, density, and modernity were extremely influential (Peterson, 1966). Similar studies have been undertaken with tract homes for new subdivisions and for the view from the highway. The choices reflecting personal preference are quite easy for people to make, much easier for example, than choosing between brands in a supermarket. Therefore, the studies seem to be tapping values that are modified very slowly; they have about the same stability as those involved in building up one's friendship network and in the furnishing of a habitation.

#### Successors and Predecessors

New life styles are emerging more rapidly than ever before, each of them introducing a slightly different twist into the population-resources interaction. Each will find occasion to express outrage

whenever the public domain it uses is also assigned to some temporarily conflicting purpose (listen some time to what yachtsmen and fishermen say about low flying aircraft). Many will discover resource categories that no one recognized before--the aforementioned surfers provide an excellent example of this. Most of the new life styles have a focus on avocation rather than vocation, but often it will be difficult to separate the two, as would be admitted by the people who live as systems analysts and speak its jargon. The increases in income in prospect over the next several decades will extend the list of unusual natural resources by scores, or even hundreds, of different categories.

For example, a series of life styles will be associated with our new marine technologies. A few instances will suggest the range of possibilities: (1) The ability of the nuclear submarine to go long distances while submersed brought into being a new kind of submariner, one that required a much more equable temperament and fewer emotional supports while at base. There will soon be more of such people than full time airpilots, to mention one vocation-based life style that is very visible in and around cities. (2) On the water's surface various forms of houseboating are gaining popularity, not only the box-on-a-barge tied to an old dock but especially the powered houseboat that moves from marinas to anchorages with the head of the family working at construction or salvage, or merely retired. Hamlets and villages of houseboats are now being formed in reservoirs and bays. (3) At the water's edge the beach fishermen have been systematically exploring coastlines, collecting data on in-shore currents and the species harbored by the landforms. (4) Soon large gale-proof floating offshore platforms will be available as artificial

islands, either moored or in controlled drift, which attract several different pleasure-bent or medically prescribed life styles that integrate with each other on shorelines. (5) The new possibilities for breeding, domestication, and training of marine animals are already exciting the imaginations of hundreds of marine biologists, not to mention thousands of amateurs. More than a score of families in Florida spend a great deal of time with their dolphins in specially constructed pools and inlets.

At the same time that the numbers of persons engaged in the traditional marine trades--sailors, longshoremen, stewards--are declining, the number committed to their life styles is diminishing even more rapidly. The turnarounds in the harbor are becoming so speedy that the crew get very little shore leave between runs, and it was shore leave that distinguished the true sailor from those who merely held jobs on a boat.

The new information technology has already produced some novelties. One of these is the "computer programmer cult" that recruits new members according to the amount of respect generated on the part of existing members of a local "invisible college." The programmer's life is regulated by neither clock nor calendar, but by the times they have opportunities to be "on line" with a major computer. They often have a chance to get free time in the offpeak periods. Music, both classical and ultra-modern electronic, is rated very high in their circles.

On a quite different plane are the "swinging singles" on the West Coast, which accent informal interaction among a well paid unmarried set more or less oblivious of sex, but physical exercise is popular, as is semi-intellectual talk that often drops back to systems jargon. This formula was invented by Los Angeles region real estate operators and

proved so popular it was widely imitated. It should be thought of however as a life style specifically created to reduce the pressure for a decision about a longer term commitment. Swinging singles establishments allow a wider search of opportunities before "settling down." The general lack of loyalty to the firm, combined with the common routine of taking a job wherever a new contract had been obtained once your own employer's contract was running out, and the nearly completed expressway networks of California that make it possible for one to cover most of the metropolitan area commuting from any single point, are all factors that created this unusual life style, one that, like the fully committed computer programmer, has had no direct precedent.

Most of the new life styles are a product of specialization. Thus, when there are thousands of yachts, the yachtsmen build up tight little circles built upon rituals suited to boats in their class. The "horsy set" divides up according to the kind of horse ridden and the kinds of territory used for riding. Dog breeders have become even more differentiated, clustering in locales according to the type of dog and the range required to keep it healthy. The musical circles have differentiated, with the pickup ensembles of string instruments still prospering in the face of much more rapid expansion of rock groups and their admirers. The latter have split again at least two ways, including both a drug dependent and drug independent life style. Examples abound, but the principle of budding off into a distinct style makes it possible to trace whole families of present life styles back to the predominantly vocational styles of the nineteenth century and earlier. In those days the seasonality, or the location of the resource that provided livelihood, imposed

an unusually rigorous discipline upon the practitioners, one that affected their whole life and that of their households.

A number of life styles are imported or adapted from overseas. The United States is at present the most influential exporter because it is a society that understands advertising and mass persuasion. The people in every country in the world are aware of the seductive messages that start with convenience goods but are followed by curricula for classrooms, training techniques, package deals, pre-fab solutions, and planned neighborhoods. Nevertheless, because it is an extremely open society, the United States imports life styles from every corner of the world, from the Zen Buddhist community at the head of the nearby canyon to the soccer football club enthusiast and the archeological communities that move between museums and diggings.

The generalization about how life styles originate and become institutionalized is only arrived at from extensive empirical enquiry, but it would come as no surprise to Miller, Galanter, and Pribram (1960). They had said that all programs for sequences of behavior come from previous programs, most of them drawn from early personal experience but some might be borrowed from outside that stream. A close inspection of the most distinctive programs would reveal a synthesis from very small fragments of earlier programs. A life style is obviously just one kind of program for action, but it operates on a longer time scale than the examples earlier employed by those behavioral systems theorists.

#### Constructing a List

How would an urban planner go about discovering what life styles were maintained in the metropolis for which he was responsible? The list should be obtained in such a way that he could enquire further, when



planning the reallocation of resources, and readily discover the potential conflicts to be anticipated as soon as the planned action was announced. Rather than suggest a mechanical procedure for rifling through the mountains of miscellaneous records--an expensive and time-consuming business--a richer, more heuristic approach will be described. It depends heavily upon empathy with a great variety of informants as well as an understanding of the processes of social organization.

Most helpful is the distinction between a style and an idiosyncrasy. Both may be strange, but the style is for imitation, even for export, while the idiosyncrasy remains personal. A style is not important as such for the social system until a circle of people have adopted it and are willing to defend their choice. Our best strategy is to admit that such a proclivity is significant for metropolitan planning only when it gives evidence for lasting over several budgetary periods and has crystallized into some kind of organization, otherwise its effects are too microscopic to be detectable at urban scale. The organization expedites the life style of the members by managing some essential service or engaging in political activity. Organizations backing life styles also engage in missionary work, train recruits, and negotiate with other similar organizations.

Therefore one way to list life styles is to identify all viable organizations in the metropolis that directly or indirectly support a life style. Viability indicates a continuing ability to act, even though no action may have occurred for some time. This is a minimal requirement that allows one to include latent organizations. Viability requires (a) a name, usually formal but sometimes informal, (b) an

address at which mail and telephone calls can be received, (c) an officer of some kind in charge of its affairs, (d) a mechanism for transferring the responsibilities of the officer dealing with the public to a successor and (e) the identification of one or more features that are focal or sacred and distinguish the organization from others. Names of formal organizations get into one or another record-keeping system (registered corporations, directories, customer lists, etc.), while informal organizations acquire an abbreviated name and a reputation if they are viable. Most gangs, secret societies, and syndicates remain informal, but will still be represented in the records of organizations by a business enterprise or a front organization. Informal associations can be found best by collating reports from politicians, police, responsible administrators, and a few businessmen whose livelihood and security depend upon being knowledgeable about such groups.

So often the organizations whose function it is to maintain and defend life style escape notice because they are taken for granted both by interviewer and interviewee. This is particularly true for the mainstream. People from the middle of the middle class, who have no strong loyalties to employer, job, avocation, or religion, normally organize their lives around their children and their immediate neighborhood. Then their commitments are to safety, resale value on their house, racial homogeneity, and the like, but only within a single grouping of apartments or a few blocks of free standing houses. The organization reflects a microscopic part of the metropolis, e.g., Homeowners Association of the 159th and Grand Avenue Precinct, the Ottawa Crescent Condominium Corporation, or the Marine Towers Tenants Association. Any of these are capable of becoming very noisy in protesting the announced route of a highway, the purchase of a house by a member of an unwanted racial group (in most

middle middle class areas American Indians are as much resented as Negroes!), or the official name assigned to some new public facility in the vicinity. The life style may then be differentiated from others by the age of the neighborhood, the relationship to elementary and secondary schools, the presence of landmarks and relics, and by friendly rivalries with neighboring groups.

The bulk of the new tract development housing is designed for this kind of a market. The geographical boundaries of the organization that defends the dominant local life style are most often set by the constraints upon land acquisition or mortgage finance prior to the time of construction.

The mainstream is being cut into from many sides due to the appearance of new life styles. As stated earlier, most of these are avocation-oriented, and the organization is usually known as a club. Members of the new life styles often fall into the category of "rural, non-farm" settlers or else they live in the many interstices provided by the metropolis when it allows homogeneous tracts to be developed and redeveloped. It is also quite possible to reside in the middle of the mainstream and ignore one's neighbors, so long as the avocation utilizes land and resources outside of the neighborhood. Thus one could even join the hordes of daredevil motorcyclists, so long as he kept a muffler on for suburban streets.

The "plastic hippies" that thronged the streets of Haight-Ashbury, Telegraph Avenue, and Hollywood Boulevard on weekends offer an even more spectacular example of escape from middle class surroundings, but in that instance the planner will not find a social club. The

people in the "scene" hold such a strong antipathy for organization that none of the characteristics enumerated earlier--name, address, "minister of information," recruitment procedure, and a mechanism for transferring the leadership role--are to be found at all. They are created ad hoc for any issue that threatens a vital resource. This life style, whether plastic or full time, does not believe in viable organizations, but only impromptu ones. Despite the ideology, however, they have found it advisable to incorporate communes as non-profit enterprises, similar to Ann Arbor's Trans-Love Energies, Inc.; the publications, art studios, and other producers of paraphernalia essential to the life style cannot interact effectively with the remainder of the society without incorporation, so those firms act as organized fronts that buffer the interface between the metropolis and the anti-organization life styles. Therefore a search for organizations that maintain and defend life styles would not at all overlook the new anarchists.

Planners need to be most careful when seeking out and identifying life styles that involve illegal behavior. Certainly the category cannot be ignored because in America, at present, an estimated 2-10% of the financial transactions alone are carried on outside of the law. The proportions of the total list of life styles that are illegitimate is expected to be in the same range. Each metropolis draws the line that separates legal from illegal somewhat differently because the definition of what constitutes a vice is changeable. The underworld of a metropolis must be as well organized as the legitimate world, but information acquired about the activities of the organizations can be dangerous to the possessor so that knowledge about the organization will be poorer. The underworld manages, for the most part, the organized gambling,

prostitution, bootlegging, burglary, smuggling and other big time rackets. Independent communities of drug-using cults, homosexual circles, sadists, and political extremists occupy relatively isolated niches in each city, but often in communication with counterparts in other cities. In almost all instances, however, legitimate fronts are created that are intended to appear extremely innocuous to the casual investigator. Since no one knows how to abolish the vices, either by fiat or by planning, the life styles that incorporate them may at least be identified and taken into account by means of their local fronts. Then the planner must be able to understand which of the underworld life styles are at stake when a new policy is drafted, and weigh the consequences of alternative proposals more accurately, otherwise he encounters a bewildering series of frustrations when coercion and bribery are being applied behind the scenes to exploit the plans for private gain.

The legitimate world, with its industries and conspicuous consumption, is far more responsible for the wastage of natural resources. The organized vices merely redistribute property and wealth once they have been produced; they are quite minor producers of litter and other forms of pollution even though a high tolerance for low grade environments is exhibited. One of the principal reasons for a minimal contribution to waste and pollution is that it is to the advantage of the criminal element that lives off the vices to stay invisible to the ordinary public occupying the mainstream. The primary influence, perhaps, is the capacity to find uses for dirty and decaying portions of the metropolis, thus making them more expensive to rehabilitate.

Society's main objection to the underworld has little to do with the environment, however, but gets into issues that are more fundamental.

The concern is with the waste of human resources through vicious forms of predation. The principal means of recruitment into underworld life styles is entrapment, either into addiction or into situations where coercion is routinely used to maintain participation. The persons living according to that style cannot escape without physical injury to themselves or loss of freedom when "fingered to take the rap," which is expressive but archaic jargon.

Compilation of such a comprehensive list of life styles and organizations that support them has a few immediate implications. The size of the list is expected to be of the order of a thousand with several hundred nominees with debatable qualifications. The population of life styles forms an eco-system with its own associations, communities, successions over time, territoriality, and population explosions. The principal feature of this specification of eco-system is that it brings out the voluntarism in the society rather than the occupational structure. Life style interaction yields a much more immediate explanation for political behavior in the suburbs and at the metropolitan level in the affluent societies than the explanations based upon ethnic origin, social class, and economic status. At this stage the simplicity and economy of the approach are as appealing as its immediate benefits for policy planning.

Example: The Campus Community

The large comprehensive university provides one of the better forecasting devices for social change in urban society, because it offers a setting for massive natural experiments in tastemaking. In the university we see an almost feverish testing of the received culture

and thus can detect earlier than anywhere else what additions and deletions are likely to be made to the mass ten to thirty years later. The campus community is larger than the student body, since it includes the faculty and most service workers and their families, many of the personnel of associated business and non-profit institutions, and a number of hangers-on. In North America today each metropolis may contain two or three such communities, each in the range of 1-2% of the total population. The core institution has an excellent capability for generating data, but the information becomes increasingly disorganized when moving to the periphery of the community. Fortunately the most advanced cultural products from the community, the scientific and creative work, are more carefully recorded and open to public view than the trivial, routine, and ambiguous ones. This makes it very different from other metropolitan communities, such as an industrial corridor, a corporate headquarters area, a medical district, or a harbor, where information is much more confidential, and therefore the basis for rumors, or else virtually obsolete, misleading, and inconsequential.

What life styles are found at present in the university community? In order to attribute value to the style other than a low level of curiosity we must identify activities that occasionally require sacrifice of the nominal rewards of university life--participation in classes, grades, holidays, etc. A list has been pulled together with three established categories, although a few listings have only recently become viable, in the sense that they are well enough organized to recruit new members, indoctrinate them, and engage in programs to defend their proclivities.

What this list says is that a student coming to the university with a prior commitment to a life style, whether romantic, amateur, or experienced, could find a circle actually practicing that life style within hours or days after arrival. (See Table One) In almost all instances the circles are so open he could be admitted with little effort on his part. Even the Black Students Union has associates of other races, and the exclusiveness of the fraternities has broken down in the past few years. Therefore the Joe College image is dead and ignored. Non-students are able to move into the community and participate fully in the outward-oriented circles but encounter resistance when breaking into the others. There are, of course, many more life styles maintained by the professors and administrative staff that admit a few students; they are not listed above but tend to be elaborations and other specializations (e.g., school administration, musicology, bibliography) of styles already represented. In the case of the nominee column, it is known that viable, organized styles to which these labels could be put exist elsewhere in university communities so they are suspected to be present in Berkeley also. Empirical study is likely transfer a few nominees over to the left hand column, but it is also likely to add many more nominees.

Despite the publicity, the communes operating in 1969-70 at Berkeley were on a very small scale. Ghetto's Inc. became Kilimanjaro House. The Unified Family borrowed vituals from Asia, as did the Student's International Meditation Society. Both Hawad and Alternatives Foundation emphasized sexuality, and two centers of the Resistance were in operation. Many similar arrangements existed but were likely



to disappear as quickly as the lease ran out; they had very little staying power.

Resource implications of life styles, particularly those that are recruiting many new members and getting access to capital, are also worth noting. The mainstream life styles require a minimum of land, therefore people and their activities can be stacked together quite densely. Conflicts begin to appear primarily when we get to the specialized life styles. The hot car drivers and the motorcyclists want drag strips and hills where the outdoorsmen, naturalists, and even the marine biologists may object, while their intown activity conflicts with almost everyone in a densely settled area.

Much more intense competition exists for the student's attention and for his leisure time than for resources in the environment. In the four to ten years spent in the campus community the majority of students report that they have often tried to maintain two or three such life styles simultaneously, not knowing where their personal commitments were strongest. Some of the campus community life styles (fraternity man, co-op member, etc.) are explicitly scheduled to be temporary and are expected to be superficial; therefore they serve principally as interlude. At this age, however, the experimentation with life styles must proceed simultaneous with courtship, recognizing that the choice of a life partner is not an independent one. Perhaps about sixty per cent of all the marital unions arise out of social contact during this testing period. Those leaving the campus after four years are usually more uncommitted and unsure of themselves and their values than when they arrived. Even those taking a technical education

Table OneLife Styles for a Large American Campus

## MAINSTREAM

Dormitory students  
     Dorm group A  
     Dorm group B  
 Fraternity man  
 Sorority girl  
 Co-op member  
 Independent student  
 Scholar  
     English literature  
     Oriental studies  
     Philosophy  
 Laboratory scientist

## NOMINEES

Outdoorsmanship  
 Computer enthusiast  
 Gambling

## SPECIALIZED (inward directed)

Classicist  
 Footballer  
 Basketballer  
 Swimmer  
 Trackman  
 Editor  
 Manager  
 Mathematician  
 Artist  
 Writer  
 Photographer  
 Teacher

Journalist  
 Counseling (tutoring)  
 Alcoholic  
 Member of commune A  
 Member of commune B

## SPECIALIZED (outward-oriented)

Musician (classical)  
 Aviator  
 Yachtsman  
 Community worker  
 Pop music  
 Designer  
 Actor  
 Television production  
 Naturalist  
 Black student  
 Chicano  
 Political activist  
 "Hip"  
 Christian missionary  
 Maharishi Buddhist  
 Marxist study

Vagabond literate  
 Poets  
 Speculator  
 Hot car drivers  
 Motorcyclists  
 Public relations  
 Marine technology  
 Marine biology

tend to be liberated from many preconceptions about proper styles of life. Thus the educational institutions serve as a pressure cooker for the redefinition and further differentiation of life style which unfolds over the following two decades, mostly in the peripheral portions of the metropolis.

#### Space-Consuming Life Styles

Students remaining in the campus community for a graduate and professional education have far more influence on the future. Their life styles are fixed more permanently while around the campus and their prospective incomes are sufficient to insure that they will be able to afford whatever they choose. Only a major catastrophe, such as war, revolution, or a breakdown in the economy, could intervene and shift their anticipations.

It can be argued with considerable force the pre-professionals are the most significant single group to study when attempting to discover trends in urban life-styles at the typical planner's horizon of ten to twenty-five years. Soon, as young professionals, this group will make up a large share of the market for the newest designs in housing that are being produced. The rich are much less numerous, and have become less prominent than before, when they provided this market; many prefer to live as if they are professionals while the remainder seek privacy in highly seclusive estates and resorts. The young professionals travel a great deal more than any other part of the population, therefore they have the opportunity to pick up foreign customs for leisure time activity and install them into American neighborhoods.

Shifts and changes in the mainstream population are drawn to a much greater degree from a selective imitation of the professional classes than from any other source, such adaptations from the farm population, poorer marginal groups, or "fads" of their own making. The young professionals seek "interestingness," "individuality," and "privacy," but once these elements are incorporated into a life style it causes the upwardly mobile leaders in the mainstream--mostly families with some college education--to attribute achievement of success to the life style. Thus the vacancies that appear in the "clubs" are often filled with persons previously identified as conforming to the more popular mainstream life styles.

During the 1960's the attitudes of the preprofessionals underwent a revolutionary change. The characteristics of the environment took on greater significance for them. As a result something like 70-80% in the Midwest and West in both the United States and Canada reject both suburban and urban central city environments as places to settle in permanently. The same trend is strong in the East and South, but it has not proceeded as far. This means that they seek a variety of locations all of them at lower density than the two-to-three homes per acre densities typical of upper middle class suburbs and something more "natural" than the luxury apartments and townhouses in town.

In contrast, during the late 1940's and 1950's a series of somewhat less populous cohorts of new professionals were thinking of roles played primarily as "organization men" with families in green suburbs or, more rarely, cosmopolites returning to urban apartments. The preferred family sizes were 50% higher than at present. They

traveled abroad much less and conformed at home much more. Perhaps only 10% opted for a different kind of life style with most of them creating it for themselves in a category referred to as "rural non-farm" by the Census.

Some urban planners regarded the low density requirements of the new life style preferences to be incompatible with other values strongly held by the young professionals, especially the desire for high grade education for their children. However design exercises applied to the growing edge of the metropolis showed that school systems with adequate variety and opportunity (a function of enrollment size and tax potentials) could be created with no more time spent on the school bus than in present day better suburbs. Thus there was little reason to believe that good schools were incompatible with life styles using up space at the rate of one acre to the household. The journey-to-work problem was more difficult to resolve but a family of new technical alternatives was being tested, and it appeared that reasonable solutions could be found for most locales peripheral to the million size cities in America. Was there perhaps some other constraint upon space-consuming life styles about which we were ignorant?

Once my students and I recognized that the above revolution in anticipations was occurring in the society of their peers we set about to test the attractiveness and stability of these space-consuming life styles (Meier, Megalopolis Formation in the Midwest, Regional Development Studies V, Department of Conservation, School of Natural Resources, University of Michigan, December 1965, and available at University Microfilm-Xerox, Zeeb Road, Ann Arbor, Michigan). This was done by seeking out a whole township where a very large fraction of the population

already lived at an on-to-the-acre density, many of them forerunners from previous decades. What were the existing life styles? What problems did they create? The life styles identified in Michigan about forty miles west of Detroit make up an illuminating list:

1. Pensioners - mostly rural origins, but became corporate or government employees. They often "winterized" a summer cottage.
2. Immigrants from Appalachia - skilled workers who wished to retain their independence. They often built their own simple home.
3. Mobile Home Dwellers - a peripatetic population engaged in construction and technical maintenance, and heavy users of public open spaces, such as lakes, streams, forests, and picnic areas.
4. Part-time Farmers - persons who have the soil in their blood, but make a full-time living in shift work or a trade.
5. Animal Lovers - hundreds had gone out to live with their horse, and hundreds more to raise pedigree stock.
6. Family Raisers - truly large families find the suburbs a tight fit, so they expand a house in the countryside.
7. Exurbanite Upper Bohemians - artists, writers, musicians, fine artisans, and their hangers-on seek out picturesque retreats.
8. Estate Builders - doctors, dentists, lawyers, and administrators buy places to be built up with solidity and permanence.
9. Sportsmen - enthusiasts about sports need extraordinary space for storage of gear, boats, and extra vehicles.
10. Show Farmers - executives playing the role of squire, but deducting the losses from their income tax.

More life styles could be detected, but only a score or so families were represented. They included such types as the teachers

devoted to a special pedagogical formula in a private school, travelling salesmen who wanted low maintenance property, and people who "just liked to fish."

This particular community happened to be split into bitterly opposed camps. It was impossible to put in a sewer line or to keep a high school superintendent. Analysis of the voting records indicated that the numbers of property-regarding types, and they tended to negate each other. The future communities should concentrate one or the other into a local district. The property-regarding components of the middle class tend to be older people, or they may have only recently achieved the propertied class and the life-style they are modelling has been around for a long time as petit bourgeoisie, but with a psychic requirement for land. They are present in California's exurbia but are frequently outnumbered, and we expect that this will happen more frequently in the future, given the predispositions of the present graduate and professional students.

The principal fault of the present dispersed form of urbanism is that it is based upon the presence of the personal automobile. The ratio of passenger vehicles to adults is greater than one-to-one. This high mobility causes extremely expensive concentrations of vehicles at all public places, particularly commuter stations and shopping centers. However, new systems for providing journeys to work and shopping in radio-controlled mini-cabs promise to be able to solve the most embarrassing traffic jams at no increase in travel cost. The current tests appear to be quite promising; indeed, the sponsors make much stronger claims than are reported here. This means that there need be no shortage

of living space for the low density life styles, except perhaps in the New York metropolitan area. Any one who doubts this should carry out his own map exercise for treating future growth. He will find plenty of land available in North America, especially if he proposed to pay an extra 50% for sanitation and roads, a sum that certainly can be afforded by the higher real incomes obtained.

In the megalopolises that are beginning to form in North America we can expect perhaps 30-50% of the ultimate population to choose styles that are basically space-consuming. When part of this space is a water surface, beach, tideland, or bog the residences may be clustered together quite closely but when it is a woodland there is more interference. The outcome is very different from the spatial structure the present fraternity of urban designers wishes to impose upon metropolitan growth, but designers have very little influence upon the differentiation of life styles.



V. Space and Time Consumption

Most human behavior in cities is tightly programmed in space and time. When an infant enters human society it is expected that large chunks of his life will be put at the disposal of social institutions such as households, schools, military services, employers, and health facilities. Urban space is allocated to such establishments in a way that the addresses and sizes are reasonably convenient. Many choices remain for the individual, however, at a more micro scale, especially choices regarding "where and when." The life style, in the present meaning of the term, enters at this more immediate stage to impose on those choice biases typical of the group that espouses the style.

Still further biases have their origin in the structure and status of the families within which the individual was raised. Finally, there is an added basis for choice that arises from personality development. Thus, undirected and unorganized behavior, lacking any plan at all, is so uncommon it frightens the normal city dweller.

The specific schedules and biases express values born of scarcity. Rules must be found which conserve both time and space. Human life needs to be conserved because it remains limited in duration. This condition is not likely to be different for at least a generation to come because there are as yet no change-producing scientific findings on hand for extending life, save in an uncommunicative frozen state. Therefore, time-saving is a strong criterion for efficiency, and a fundamental reason for the existence of cities.

Urban space requires the expenditure of human time in order to gain access to it. Therefore, if time is to be conserved, space must be treated in like manner. Interestingly enough the surface of the earth sets an absolute limit upon the supply of living space, but the urban regions make use of less than 1% of it. The remainder is unoccupied except by farmers, herdsmen, and tribes living close to subsistence in a few relatively temperate land areas while the water surface, which is such a predominant feature of the earth, has virtually no permanent settlers. The concentration of people into urban spaces, subject to an urban scheduling of their time, is presently proceeding very rapidly, but even more rapid is the connecting of the metropolitan areas around the world with each other. The jet ports and the telecommunications systems, together with the operations of governments, markets and large firms, are forcing a meshing of schedules despite the time zones and thus inducing a new urban layout. Carried to its ultimate rationale of time and space conservation, significant portions of each major metropolitan area will be forced to undertake round-the-clock operations. The transition must be accomplished in order to remain competitive with other metropolitan areas; the advantages that can be obtained will become clearer as the discussion unfolds.

However, time spent for human purposes remains no more than a crude indicator of the potential importance of the respective purposes. The time spent in interaction is most highly valued, so it is interaction that is fundamental. Experience is made up of the rehearsed residues of learning acquired from previous interactions. Therefore, a good city will, for almost all its citizens, permit the compression of several ordinary lifetimes of participation and experience into one. Ultimately

that is what resource-conserving should mean when applied to the human time budget.

This point is so important a brief interpolation needs to be made about the exceptions. At present about three to four per cent of each cohort in an advanced society is physiologically unable to participate in the normal educational process. The reasons range from accidents to illness to genetic defects. In addition, however, there is a small fraction that finds a high pace of interaction stressful, leading eventually to life-shortening physiological responses. They seek out niches in the metropolitan environment that enable them to make a living with much less than a normal level of participation. Interaction should not be demanded of a person by the urban milieu if he is likely to acquire an ulcer as a result. Therefore, there will be a fraction, perhaps in the neighborhood of ten to thirty per cent of the population, which will not choose to use its time for participation or even for gaining experience by interacting with the environment. The remainder seem to crave participation to varying degrees, so the danger for them in the future as cities become more effective in responding to this set of wants, will be that of being pushed inadvertently into an overloaded condition. At present fewer than ten per cent of the urban population are in positions where they occasionally face this danger. The majority would undertake to acquire more experience if it was convenient, and their lives are a long way from saturation.

#### Social Order in Space and Time

Returning to an earlier theme, order in cities requires an allocation of space and time to fit the necessary tasks for survival and, much more demanding, the freely selected life styles. However, what

people, including experts, actually assess intuitively in their environment is not order by itself but the amount of disorder they experience. They note the error, the noise, the accidents, the lack of co-ordination, and the paradoxes. Thus, when life styles are nicely territorialized, hierarchified, and stabilized over long time periods a high level of order is agreed to be present. Invasions, revolutions, status challenges, loss of interest, and erratic oscillations are recognized as evidences of disorder in the social system.

Let us take up the problem of order in the modern, relatively affluent metropolis first. There the respective life styles are selected from an array of existing and utopian types contacted by the individual in the course of his prior personal explorations. A large share of the preferences are generated at an early age. The urban youth is normally encouraged to wander about in his environment in search of personal opportunity. He usually seeks a peer group, or gang, with similar predispositions in the form of personality, family environment, income expectations, level of educational aspiration, and physical capacities, and offers to join one or more that seem to "fit" the best. If he is accepted, he has committed himself to spend hundreds, more likely thousands, of hours of his time in their company. He seeks their approval by competently imitating the essential rituals in their social behavior. This experience narrows the range of choices that are likely to interest him later in life; it determines the niche he aspires to in the urban order.

As affluence increases further, the range of possible choices maintained in a metropolitan region is extended; the variety of life

styles kept going is also enhanced. The presence of variety is essential to the development of human resources and competition between life styles is desirable for the same reason--both features require a closer fit with genetic potentials in the individual and they sharpen attention. However, open conflict with its exhilarations, terror and destruction of the environment, is one important aspect of variety almost always rejected, because conflict has serious long range choice-reducing consequences. Order in affluent environments implies stabilized variety, new styles displacing the old by appropriating their resources rather than through predation. Peace-keeping in cities is particularly productive in the post-industrial metropolis.

Compare this outlook with conditions in the poor, struggling cities which offer people very few more choices than they would have in the village. In such places, life style is predominantly attached to vocation. Most features of style in such areas, for example, the place of residence, its furnishing, the patterns for visiting, the holidays that should be celebrated, the rituals that need to be maintained, and even the modes in clothing worn by members of the family, are determined by the head of the household, who is more than half of the time at least one to two generations older than the person whose life is being programmed. Similarly, almost all the marriages in such cities are arranged between the heads of families, and only when the fortunes of the families are improving do these contracts allow for a modernizing shift in life style. Thus, a poor city is locked in by a number of reinforcing feedbacks so as to maintain its traditional life styles; representatives of the past make commitments to the future, and their

function is seen by the citizens as one of conserving a unique, but known, way of life. Nevertheless, it must be remembered that a large city is particularly attractive to marginal persons, broken-up families, outcasts, ex-soldiers and others who were poorly served by tradition and who do not readily fit in the mold set by the majority.

Once given an infusion of new income, however, such a city begins to display a modern sector that encourages contact with new vocations and consumption patterns. Every city that deserves the term being applied to it will now have a modern sector; moreover, almost universally the modern complex of activities grows much more rapidly than the traditional. Modernism introduces the new and far more exciting life styles in a way that is only loosely connected with the known vocations because modern living is said by the economists to be much more consumption-oriented, by which they mean that socio-cultural and creature comfort values operating outside the market place dominate the choice.

A major stimulator of economic growth and social change is the active contact maintained between cities. Trade in artifacts is well understood and is managed by a merchant class whose niche in each society is well defined. The profits tend to be invested conservatively and, therefore, trade induces social change very slowly. Visitors provide a second kind of contact, but they are normally encapsulated by a tourist industry; the ridiculous behavior of strangers usually insulates them from the real city. However, the injection of information-bearing people--scientists, technologists, enterprisers, managers, students--has expanded ten to a hundredfold beyond customary numbers in many urban places so that this contingent can no longer be accommodated as the wise men and pilgrims

were in the past. The seasonal rain of penetrating extra-cultural human contacts brings about an erosion of tradition. These strangers bring in their wake streams of messages--letters, reports and presentations of ideas purveyed by the mass media. The messages stimulating attention and laying the groundwork for change tend to flow from the most cosmopolitan cities in the world directly to the most provincial but it may take two to ten years to get discernible internal reallocations in the time budget, whether they are tastes in popular songs, styles in grooming, dress or furnishing, new approaches to contraception, or new festivals to celebrate.

Once the knowledgeable people actually know better about how to manage interactions between cities, how should they act? The planner's chief strategy for the poor city, if he is to survive as planner, becomes that of maximizing the velocity of exchange within the modern sector. The modernizing contingent seeks more transactions while the larger traditional component tries to return to the status quo. Development planners aim to create productive new jobs and enhanced income mainly by coordinating investment and location, but those efforts must be preceded by carefully selected investments in education (which in such places means the investment of time and attention for information acquired via the various media of communications). Life styles based upon avocations should only be planned when full employment is in prospect, but a good chance exists that larger ecological issues would overwhelm them.

In post-industrial America, the most advanced instance, the planning must respond to multiple pressures of a kind that will be faced in Europe and Japan one to three decades from now. In America we foresee the need to provide for an extra hundred million population expected

to be added to the urban settlements of North America over the next three decades, which amounts to a near doubling in number. Half of these would be immigrants from depressed areas, many of them overseas. In addition, space must be found for their valued artifacts--automobiles, second homes, appliances, telecommunications systems, computers, and earth satellite stations. Finally, the planners will encounter the unprecedented sophistication induced by advanced education and day-to-day contacts with the most advanced equipment. Under these conditions only one identifiable threat remains--too much interaction at critical times can build up localized communications stress, so it constitutes as much a cost in the real world as too little interaction. Therefore, equalizing the distribution of social participation through public transactions per unit time becomes an appropriate objective of the planners. Such policies are already sensed as being appropriate today for the problems of tomorrow but the rationales offered have derived from common sense or micro-scale experiments and tell us nothing about how the social optimum can be approximated. (cf. Psychological Stress and the Ability to Cope, 1966, author yet to be found).

Tradeoffs: Space vs. Time

Some of human time and a small part of the earth's surface are worth money and can be traded back and forth on the market. It is curious that modern societies allocate 9-12% of human time to the labor market, where a dollars-per-hour value can be placed upon contributions to organized efforts. Beyond that the market is felt to be coercive or corrupting--a kind of slavery. Avocation-based life styles in particular



tend to wall off these closely calculated aspects of human action so as to prevent their spread into the remainder of life; they commonly designate monetized calculations as "not sporting" and proceed to evaluate the performance of peers on other grounds.

Similarly, somewhat less than 10% of the earth's surface has acquired a significant market value, and of this only one to two-tenths of one per cent has entered the urban land market. Nevertheless, the preponderance of total land value is found in the immediate neighborhood of cities, even if one takes mineral rights and standing timber into account. The physical capital of modern societies is concentrated in metropolitan areas, and the land component in the land-cum-structure-plus-guarantee-of-access-to-utilities packages that go on the market (including empty land upon which structures may be added later) is assigned at least a third of the value. In Asia, Europe and much of Latin America the proportion tends to be over half.

The tradeoff can then be calculated between territory and time. The economic rent for action space--mostly employment, residence and services--can be equated to the earnings obtained from 20-40% of the employed time. There are major imperfections remaining in urban land markets, but it appears at present that the lower the worker productivity in a metropolis the higher is the proportion going to rent. If true, this relation has some fundamental implications for city formation.

The reasons for the accumulation of value attributed to use and control of the land in poor cities are partly understood. A principal factor is the cumbersomeness of the transfer process itself that prevents many areas from being converted to new uses. This molasses-like response

to demand very greatly reduces the supply of locations available for new uses and stimulates a bidding up sequence. A number of devices, such as title insurance, have been introduced into more advanced metropolises for overcoming difficulties in property transfer. Routine availability of credit on a high proportion of the market value of land may increase the number of bidders and therefore increase the value of land, but it also smooths the oscillations in land values. However, the major process is the separation of the space-intensive elements of urban life, such as raising a family and outdoor recreation, from the action-intensive and the cash-oriented, such as work and indoor recreation. Some of the time and income (time is almost always the most valuable component) is assigned to transportation between the two locales. Extensions of transport systems increase the supply of land; they simultaneously increase opportunities for the differentiation of life styles.

Note how this discussion slipped from the grand, abstract concept of life-space to the mechanics of the land market when introducing the tradeoffs between life-space and the time to live according to a life style. One of the reasons is the limitation of man in occupying three dimensional space--much planning and organization is required to sustain him if he rises above six feet from the earth's surface. The same can be said for living on or below the water surface. Technological advances have made both air rights and aquatic surface rights valuable in a few instances already, but their combined role in the future is to add much more significantly to the existing supply. The space-money and time-money tradeoffs are still conveniently assessed by the land and

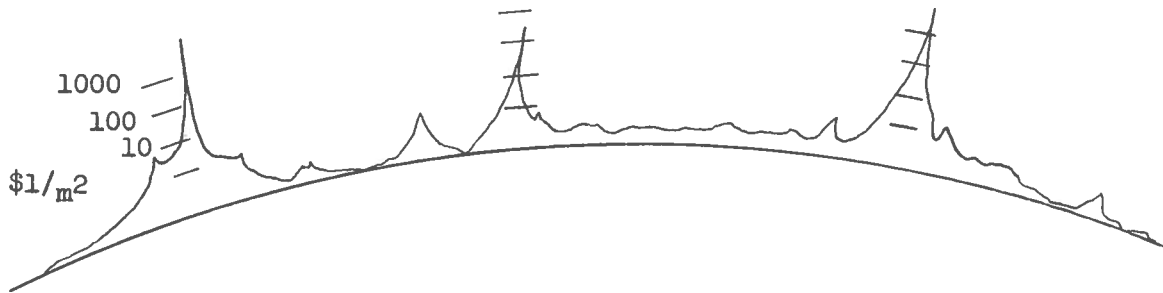
labor markets as a first approximation, and this is likely to remain true for as much as a generation or more in the future.

Very simple representations of the outcomes of a smoothly working land market can be constructed. They do describe what happens in almost all metropolitan areas with a high degree of verisimilitude; the exceptions are subject to a considerable amount of distortion due to physical barriers, political boundaries or religious prohibitions. When land values are plotted as if they were the altitude on topographical maps, the picture presented is a set of thorns emerging from a bark-like surface. The central districts represent the sharp points of the "thorns." (Fig. V-1)

Geographers have explanations which account for the location of the precincts with highest unit value. Many of them are political (e.g., the establishment of national and regional capitals), others are attributed to break of bulk in transport as with port cities, and a few originated because of very rich discoveries of natural resources in the vicinity. The highest values are assigned to those plots of land that support the executive headquarters of firms and agencies, and the most intensive retailing. The value of specific plots of land is, in first approximation, a function of accessibility--the inverse of the time required for people to get to it. However, among Tokyo's 23,000,000 residents and sojourners, several other factors could shift the price of land by as much as 10-40%. They include (a) the localized pollution effects caused by neighboring industries and the landforms, (b) the vulnerability to severe floods, slides and tides, and (c) the localized loss of an historic function with no immediate replacement on hand. (Example: Several years after the Japanese government abolished legal

Figure V-1

LAND VALUE ACCUMULATIONS ON THE  
SURFACE OF THE EARTH



The above map would be representative of a heavily urbanized area such as New York-Philadelphia or Osaka, Kyoto, Nagoya.

prostitution, Yoshiwara, the largest red light district, was reporting land values 20-30% below what one would normally expect from that level of accessibility and freedom from air pollution.) Proximity to parks and open space, although spoken about a great deal, does not seem to add much to land value in Tokyo, but this may be different elsewhere in the world (Wallace Smith, 1968).

Census tract data for cities are very misleading, because they emphasize the density of population when almost everyone is somnolent, and activity is minimal, so that accessibility measures based upon time cost from place of residence will explain only the grossest relationships. The daytime population comes closer to being the significant statistic. But how does one define "daytime" in a metropolis? Perhaps it is better to measure a flux--the number of persons coming within line of sight of various addresses in a sample. Then it would be possible to make a linear transection of a metropolis that shows the relationship between day and night density. Note that addresses sampled for daytime population have a huge degree of variability. (Figure V-2)

Accessibility to daytime populations is obviously the best predictor of site value. Merchants behave as if this was true, as do billboard advertisers, hawkers, and proprietors. It often pays to make fine discriminations as to age, sex, income and mode of transport. Urban designers will attempt to manage the densities and the flows so as to minimize congestion and in general try to make the higher densities not only tolerable and advantageous to the bulk of the population but also pleasurable on many occasions.

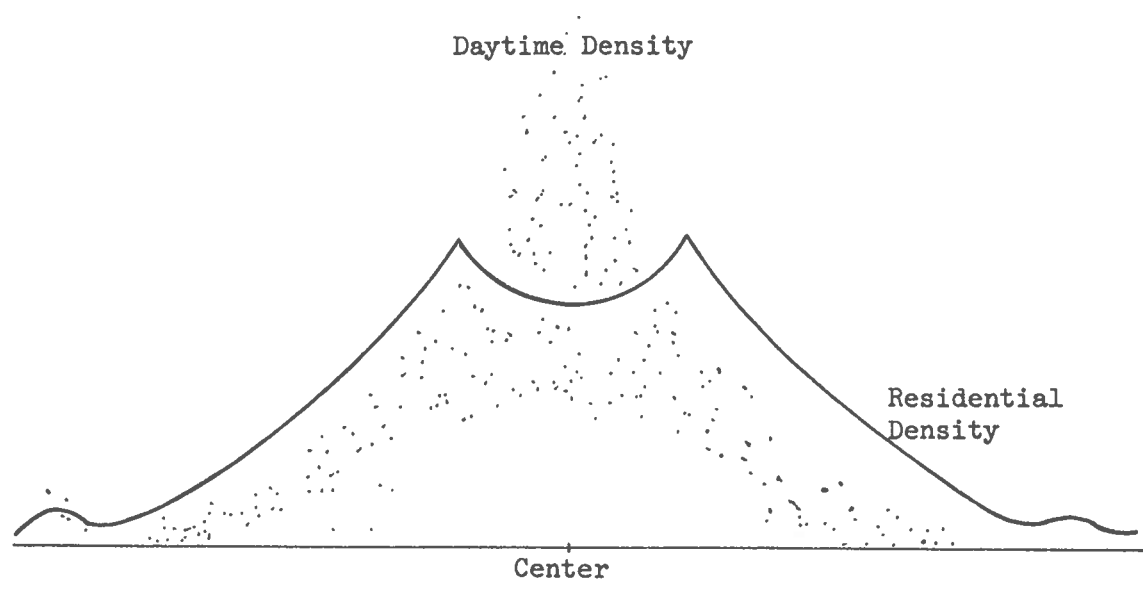
It should be pointed out that the cost of acquiring comprehensive information about daytime population density for a real metropolis is so

great it has not, to my knowledge, ever been accomplished. One way of carrying out the task requires the identification of several thousand representative places in the city. For each of these a cordon of counters would need to be prepared to catch the numbers going by as pedestrians and as drivers of cars. In order to avoid the effects of weekly, monthly, seasonal and other cycles, the equipment should be there for more than a year in the benchmark study. Corroboratory information simultaneously is obtained from attendance counts, visitor registration and a number of similar devices. Thus density, day and night, can be reduced to the average of a squiggle on a graph, each hour of each day made up of scores or hundreds of observations, and each year of hundreds of thousands or millions of individual counts. When these averages are mapped, the results must still be dispersed, as in the daytime population distribution in Fig. 3.

There is an alternative means of going about obtaining daytime densities. A sample of the population could be given wristwatches with randomly set alarms. Each time the alarm goes off he or his guardian records when and where he is and what he is doing. Here, too, the study would take more than a year, but the amount of data generated would be much less and the quality of findings for the downtown area much cruder. This is a people-oriented approach, while the former is a land-oriented measurement. Each requires a number of steps in error-reduction that are quite independent of each other but they should converge upon the same phenomena, giving us a picture of the living metropolis rather than the sites for sleeping, and they should yield density distributions that closely resemble each other.

Figure V-2

IDEALIZED DENSITY DISTRIBUTIONS:  
THE METROPOLIS BY NIGHT AND DAY



Sampling urban places and counting movements of humans in, out and around them leads to some predictable biases in the outcome. Perhaps the most important of these is that 3-10% of the locations likely to be selected will change their function in the course of the study, so the information produced is obsolescent. The people-oriented method is likely to get poor responses from the least literate portion of the sample, as well as those who are operating some of the time on the shady side of the law. The census also under-reports such persons. Therefore, maps produced from such data will understate the density around the haunts of the poor and the wicked.

The best assessments today of daytime population can be inferred from the large scale transport studies of the metropolitan areas. However, most such studies are limited to main arteries of flow and they keep track of vehicles much more closely than people. Traffic studies rarely take account of pedestrian movements.

The place a person is in a city at any given time of day is almost always the result of prior calculation on his part, that of his employers, or his servicers. When that calculation was made, and occasionally it was a long while ago, the tradeoffs between space and time were set. As opportunities and costs change, the locations usually remain what they were, except for involuntary removals, until some agonizing wrenches of relocation of activities are set into motion.

#### Transactions as Tradeoffs

Even the distribution of daytime population in a metropolis is misleading. Intuitively we feel that people regard their time in the high density zones as more important on the average than the time spent



in low density areas. Certainly the price of land reflects this attitude. The rent of a man-space for a few hours' work per day is usually greater than is paid for home-space which is occupied a much longer time. When the difference is analyzed it becomes apparent that many more identifiable public transactions are completed per unit time where the daytime population density is high.

Everywhere one looks it is clear that the modern metropolis is arranged to expedite social transactions. The city that generates the most action of this type also produces welfare. Those cities that offer more efficient physical facilities and services than the others will attract the most ambitious actors, along with scarce resources, and thus will produce an even higher intensity of transactions than before. In theory, this immigration should continue until the cost of inter-city movement equals the gain derived. Thus, the transaction levels achieved in various cities may be used to explain not only the population densities at various times of the day and the values attached to spaces, but also the satisfactions obtained in the respective urban environments.

A transaction represents not only action completed in the market place but especially such non-market behavior as trips, telephone calls, letters, face-to-face encounters and conscious exposures to the environment that include advertising messages as well as gardening and outdoor recreation; to these we must add all occasions for reading items of text, viewing selections of television, listening to radio or recordings, and other similar exchanges.

Each transaction is entered into voluntarily by the person or group in the hope of deriving private gain. If an initiator should be

frustrated several times in a given context, he allocates his time to other media or he may change location (Figure V-3).

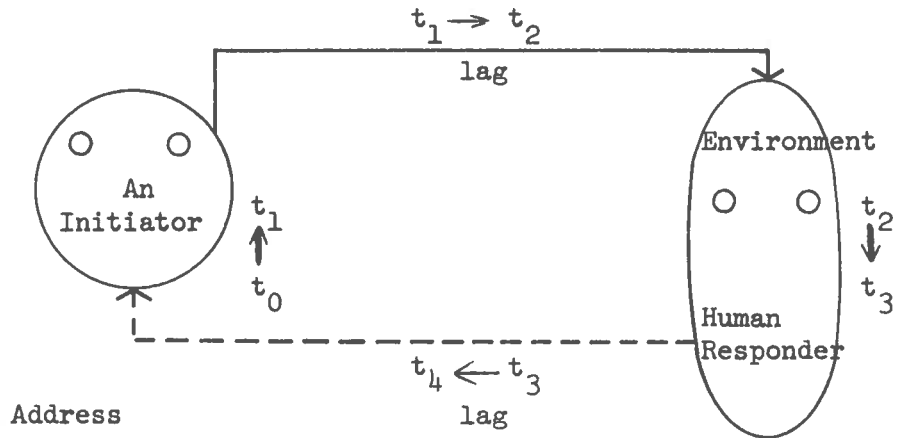
Suppose these transactions--including all the large, medium-size, and as small as are readily discriminable--were to be mapped so that addresses of origin and destination are both marked. With so many of the utilities and retailers going to electronic data processing systems and each metropolis maintaining a continuous sample of passenger movements, it will soon be possible to make a continuous estimate of this sort. Each able-bodied person would be participating in somewhere between 30 and 1,000 transactions per day. The high end of the range may be raised somewhat under conditions of crisis. The mapped outcome would be even more peaked for the center of the city than population density, but the schools emerge as locales for intense interaction comparable to the government and business offices downtown. On the other hand, recreation areas would register a rather low density of interactions, even if they were relatively densely used (Meier in Daedalus, 1968).

It can be argued that the density of public transactions creates land value. People are willing to invest money and effort in order to expedite the flow of transactions. However, a detailed scrutiny of the relation between land value and transaction rate uncovers some noteworthy discrepancies. They include:

1. The top of a mountain with line of sight over the whole metropolis generates land value equal to the highest downtown prices on a square foot basis. The peaks are occupied by automata operating television transmission antenna, microwave relays, weather stations, aircraft guidance systems, long distance radars, observatories, and undisclosed

Figure V-3

THE UNIT TRANSACTION



Time invested by initiator  $t_1 - t_0$

Time invested by responder  $t_3 - t_2$

Other investments: energy  
matter

Payoffs: Utility gain--Initiator usually greater  
Information gain--Responder usually greater

military instrumentation. The human population at the site is limited to a few construction hands and maintenance men.

2. Land in the "best parts of town" will have a low transaction rate per unit area even though it may be high on a per capita basis. The consumption of space is an indicator of high status, one which is likely to be registered in at least one or two posh communities in every American metropolitan area, so the cost of land will be abnormally high due to status value.

3. Most interface zones for transferring large and bulky shipments (waterfronts and rail freight terminals are excellent examples for the late 1960's) will stimulate low transaction rates per capita, as well as per unit area, but nevertheless generate the bases for a relatively high land value.

Thus the urban land appraisal specialist will attach a high value to any tract which has a high potential for transactions. He must seek out as well its uniqueness for expediting the flow of essential transactions, and expects to discover the values arising from quasi-monopoly. He would recognize that each completed transaction implies at least a two-party concurrence on the significance of site, action space, and the relative value of human time. Some kind of a deal, however trivial, had been reached and relatively long-lasting values of time and space had been agreed upon between the parties. An appraiser of real estate can judge these joint values with a much higher degree of confidence than the quasi-monopolistic values.

The difference between rich and poor metropolises will reveal some significant connections. Dallas, Texas, and Kanpur, Uttar Pradesh (India) are metropolises roughly the same size in similar climates.

Moreover, each is also about 35 miles away from another metropolis of almost the same size, a condition that is expected to intensify somewhat the level of activity. Dallas has a level of income about the United States average--\$4,000 per capita per year--while Kanpur is slightly above that of India--say, \$60-70 per capita per year. (Table V-1) Obviously the Indians extract less welfare for themselves out of the social transactions expedited in the metropolis. To an important extent this is because transactions in India are more repetitive and convey less information.

The developmental task for Kanpur is therefore only in part the expansion of the social transactions per capita. To an even greater extent it seems to be the increase in variety and informativeness of the transactions that can be selected by the residents and sojourners so as to fulfill personal needs that must be expedited. This characteristic might be judged by the richness of the imagery involved in the transaction, or the amount of learning generated in the process of making a deal. The information transmitted in a social transaction often produces the kind of welfare that can be estimated in terms of income. Thus, one feels from on-site observations that Kanpur must invest in more education, more transportation, more printing, more telephones, and more channels of mass media in order to make it an effective welfare-producing metropolis. Being poor at the moment, it must accomplish this speedup and enrichment while economizing upon capital investment. Kanpur needs newer and better adapted technologies than those employed by Dallas in order to accomplish such progress, specifically channels that use electromagnetic spectrum rather than copper wire.

Table V-1The Pace of Social Transactions

(Population Average Estimates: 1970)

	<u>Kanpur</u>	<u>Dallas</u>
Purchases (by item)	~ 3	~ 5
Checks and Credit Card Payments	-	0.5
Trips (vehicular)	1.0	2.0
Telephone Calls	0.1	2.2
Mail	0.1	1.0
Shipments	0.05	0.2
Newspapers Read	0.2	1.0
News Items Noted (including advertisements)	~ 1	~ 10
Classes Attended	0.3	0.6
Library Circulation	-	0.03
Television Viewing Hours	0.1	1.9
T.V. ("exposures" to messages)	~ 1	~ 30
Radio (hours)	0.2	0.6
Radio ("exposures")	~ 1	~ 10
Face-to-Face Exchanges	~ 10	~ 20
Physical Environment (items consciously noted)	<u>~ 8</u>	<u>~ 10</u>
Total (per day):	25	90

Future Round-the-Clock Operations

Diurnal fluctuations in intensity of transactions in the metropolis seem likely to become much less prominent in the future. A number of reasons can be found already for this equilibration, each of them working in a different way to overcome the inertia that dominates the daily schedule of activities in a city at present. Seasonal fluctuations, in those places where they are extreme, are also likely to be damped out over the next several decades. These reorganizations entail quite a drastic change in urban space and time budgets. The directions that the shifts may take become particularly evident as alternative transport-and-land-use-systems are prepared for newly evolving metropolises and their costs compared with prospective benefits.

Today one finds in a modern metropolis that about 2-5% of the labor force will operate the facilities needed by the public between the principal shifts. Thus power plants, telephones, transport systems, radio and television stations, oil refineries, and large computers are kept going with minimal crews. Services such as hospitals, police, fire protection, filling stations, all-night restaurants, and similar refuges have evolved provisions for off-peak working and employ an extra several per cent. In addition, a more variable proportion of the labor force works these hours in order to assure the maintenance of urban facilities that are otherwise intensively used--street cleaning, office cleaning, waste disposal, vehicle maintenance. Finally there is also an indefinite category whose hours of work are set so as to be complementary to the nine-to-five peak density in the city center--hotel staff, dining service, entertainment, theatrical performances and music.

Motivations affecting the choice of an unusual work shift are many. Recently arrived immigrants find that such work allows them to study, practice an apprenticeship, or to seek other work more appropriate to their skills during the regular shift, so it serves very well as an interim means of support. They often hold onto it as a second job that allows them to accumulate enough capital to join the proper-tied classes. A few people with night time work shifts strongly prefer the arrangement because they have chosen life styles out of the mainstream--religious service, gardening and animal training are typical but sometimes this preference may also be attributed to an inability to cope with stressful situations. The price differential paid by large employers for standard technical and engineering services on other than day shift usually only runs 10-20% more than the day shift. However, worker productivity, wherever it can be measured, is almost always reduced, often quite sharply. The difference may be traced as often to the unavailability of information, parts, or services, as to lesser proficiency or managerial control, but lesser competence is often a contributing factor.

In very poor countries now undertaking economic development it would be expected that economic use of capital-intensive equipment would force modern industry to use a multiple-shift formula. All jobs immediately linked to the scarce facilities would also be converted to some compatible arrangement. The national economic planners in India were particularly sensitive to this "idle capacity" in industry and transport and tried to devise laws, measures, rules and strategies for assuring "multiple shift operations." No more than a few localized successes were achieved, however, because strong forces were acting to maintain the single shift.



Managers of firms in such countries encountered the strongly ingrained rural standards of behavior in the unskilled and semiskilled labor force. Many men could not adjust to working at night when all the rhythms of life presumed daylight work. Nevertheless, some of the construction workers handling brick and concrete could be induced to work hard at night in larger cities, especially if paid sufficient bonus. Many bitter complaints were registered by the entrepreneurs, mostly concerning inconvenient power and water service cuts. The lack of community-sponsored buses was especially serious because workers ruined their bicycles in the ruts of unpaved, unlit streets. Thus, to guarantee factory labor for evening shifts the employer would have to provide tied housing within a short distance of the plant for each of the three men assigned to a single work station. The capital cost would run \$500-\$1,000 apiece, and even then only a fraction would live with their families, the remainder being boarders or living in barracks. On a single shift basis employers would expect that workers would arrange for their own housing, often obtained through self-help and equally often near the end of a commuter line. The saving in capital involved when adding a job in the modern sector by round-the-clock working is therefore not as substantial as the Indian economists had imagined; moreover, the management task became so complicated the productivity-per-man-day inevitably declined.

More advanced metropolises have found multiple shift operations no easier to implement. All the specific complaints of the employees can be met. Nevertheless, the plants encounter difficulties as soon as full employment conditions are approached and daytime jobs can be obtained by nightshift workers. Retailing and services remain heavily in the

hands of single-household firms so they find it impossible to extend the workday. Cities as cosmopolitan as Tokyo and Hong Kong shut down almost all transport services before midnight and resume again about six o'clock in the morning. Both exhibit a strong nine-to-five peak that has been deflected to some extent to early or late starting times, but few other adjustments have been made.

Many experiments were conducted during war time in the 1940's to move a whole city into round-the-clock functioning. Many new persons were added to the labor force to expedite the reorganization, and reductions in the quality of urban services were tolerated for patriotic reasons. Any person experienced with human organization would have thought that once an adjustment to a new schedule had been made, the organizations involved would be reluctant to spend the time and effort needed to shift back. For example, a related phenomenon--high female participation in the labor force--provides an instance of what kinds of things experimented with in wartime have been continued ever since. However, the night shifts speedily evaporated. There appear to be many coincident reasons for the most modern cities to be locked in onto the prototypical day shift, but a very strong force can be detected that is often overlooked--synchrony.

The highest status people generally assign convenient times for others to work, and this forces their staff to appear on the scene one or more hours earlier. The telephone is used to prepare the way for significant transactions to be completed by the leaders, but the telephone is not efficient for any office that starts too early or too late. The offices out of phase are limited to four to five hours of preparations

per day while the competitors on regular hours get six to seven. Since the early bird gets the prize very often, the firms and government offices that try to escape the congestion find themselves missing the best opportunities and thus are forced to go back to regular hours or disappear from the scene. Thus, it is the cut-throat competition between entrepreneurs, firms, and governmental bureaus that prevents fuller use of the valuable capital equipment set up to serve central city facilities. A shift might be achieved only if the top of the power structure that dominates government, finance and industry also goes over to round-the-clock decision-making. The last positions open to true gentlemen at the top of the hierarchy would be removed by such actions, so the Establishment that has taken an interest in leisurely attainments and high style and moves in elite institutions would normally exert its veto. Why jump into this inhuman merry-go-round? Their attitudes are amplified and reinforced through the ranks of the college-trained organization men. One detects no demand from the top for this approach to efficiency.

Thus, the diurnal cycle inherited from agriculture, and required in the cities during the steam-steel-rail expansion because of the cost and inconvenience of available lighting, continues to dominate urban schedules despite the new freedom from the fear of darkness introduced by electricity. In addition, the telecommunications technologies introduced reliable transmission of messages regardless of time of day--a freedom from being isolated. Theory suggests that such a social lock-in that prevents further advance (and there is considerable progress that could be achieved in the poorer countries once the bind is broken) is normally eroded away first within some minority group that has undergone some conversion in beliefs, has reshuffled values and has acquired

specialized knowledge. Very likely it is the knowledge component which will be most important for leveling out the diurnal cycle in the next several decades mainly because technological capabilities have recently made several spectacular gains.

#### Synchronizing the World's Cities

Over the 1970-1985 period all of the major metropolises of the world are likely to be reconstructed in such a way that hundreds of thousands, perhaps millions, of people will be forced into institutions operating around-the-clock. Corporate planners, aerospace systems groups, and the most knowledgeable of real estate investment firms came to recognize this outcome some time during the 1960's and have been adjusting their commitments and portfolios accordingly. The forces at work are best described as they affect a specific case.

Tokyo's international airport was pressed to accept a substantially greater rate of growth of passengers than Japan's successfully stimulated expansion of international trade. Thus within five years after the 1964 Olympic Games the Haneda location was repeatedly overwhelmed by the two-way passenger flow. The airport itself could not be adequately expanded, nor could the capacity for collection and distribution of passengers be enlarged. After systematic exploration, the government settled upon the Narita site for the new Tokyo region jetport; it was about 130 km. from central Tokyo. The distance required that the New Tokaido Express be extended to the northeast in order to assure that the airport would be convenient to the executive headquarters in the center of Tokyo. Tokyo's jetport would therefore be designed to be at least as near and handy for its heaviest users as those in New York,

Washington, London, Paris, Moscow, Los Angeles and San Francisco. The decision was to go ahead, over the objections of local farmers and the university students. The secondary adjustments would be made later, many of them after the construction is finished.

The Japanese discovered that a modern jetport spills over into many ancillary economic activities. They had not experienced many of these adjustments before because their principal airports had been surrounded by heavy industry and the new activities could not find a niche in that environment. Air freight was soon expected to deliver about 20% of the Japanese exports, mostly to its best customers on the other side of the world. This meant that the best location for a number of firms in the garments, electronics, flower cultivation, pharmaceuticals, toys and similar industries would be in the vicinity of the jetport because they might then use sub-assemblies or components arriving by air. Some industries, such as printing and pharmaceuticals, are relatively automatic and could be put into the noise shadow of the landing pattern of the jets, while others would demand sites adjacent to the executive offices, hotels and recreation areas. However, the airport must go round-the-clock because keeping the aircraft on the ground when a demand for trips exists some place in the world is too expensive. All the activities surrounding the airport will be swept along by the urgencies affecting the international firms operating and using the planes. Therefore, whatever peaks exist will be adjustments to some unusual demand exhibited in a still greater inducer of traffic than Tokyo. Los Angeles is just such a possibility.

Actually, in Los Angeles one already perceives a community of several hundred thousand people who are diffused throughout the metropolis for their residence but they help keep the airport district going

on a virtual twenty-four hour and seven day week basis. The number of people involved is growing very rapidly, perhaps 20% per year in the late 1960's. Tokyo must anticipate pressures for growth that are even stronger. The express railway should connect with no more than two points of Tokyo, otherwise the value obtainable from its high speed would be lost. One of these stops must be Tokyo Station, the point that presently experiences the greatest commuter traffic and congestion in the world. The other point would, of necessity, be dominated by the new opportunities presented by the jetport. Therefore this interstitial point must be visualized as a "new town" that grows rapidly to several hundred thousand people.

It would need to be the first new city of that size designed to synchronize with a round-the-clock facility. Some economists and urban analysts foresee that the airport, together with the information transmitted invisibly by communications satellite from other metropolises of the world, would enforce a synchrony of the inner four wards of Tokyo which contain the top decision-making, merchandising and entertainment districts. Perhaps a million persons will have been swept into this vortex by 1985.

Organizational revolutions are implied, because the current decision process of the Diet, Cabinet and zaibatsu are too rigid to fit. Possibly an executive team of five to seven members would be created to meet full responsibilities for running the organization, perhaps with candidate members always on hand. One or two would be traveling while the others tended to organizational affairs. An alternative, proposed in America but agreed to in some circles in Japan, would analyze the style of the decisionmaker, in addition to the constraints of law and

precedent, and a computer would decide until over-ruled. This last idea would apply to responses to market changes in particular. The crust of tradition is beginning to break in Japan, so it does not seem impossible any longer that the top elite may reshuffle its schedules. It will come with great anguish, however, if it comes at all.

The future that faces Tokyo should affect Hong Kong, Bangkok, Athens, Tel Aviv, Delhi, Taipei, Seoul, Manila, Teheran, Singapore, Karachi, Cairo, Istanbul, Bombay, Kuala Lumpur, Djakarta, Ibadan and Sydney over the succeeding decade more or less in that order. Obviously all kinds of events could intervene between now and then. However, an assessment of their location in the world air route network, the expectations for the volume of use of the channels provided by the communications satellites, and the local rates of metropolitan regional development all contribute to the likelihood that this path will be taken in the future.

To bring these observations on the forces expected to overcome the inertia of diurnal cycles to an understandable conclusion, it is necessary to review the equivalent trends in pace-making North America. Here the pressure for round-the-clock is likely to come from the crowded skies over New York, Chicago, Los Angeles, Washington, Miami, San Juan and Honolulu. Congestion in the airplanes at peak hours is causing a spreading of the schedule so that many more passengers will henceforth start their journeys in off-peak hours. At the same time, careful investigations are now being made of high-speed rail and even "tube transit" services that would reduce the pressure on the airplanes. The linear axis of a megalopolis (e.g., Portland, Boston, Hartford, New York,

Philadelphia, Baltimore, Washington, Richmond) is admirably suited to obtaining quick payoffs from the sizable investments. Somewhat later Chicago would be connected to New York-Washington both through Canada and south of Lake Erie (Myrto Bogdanou, Ekistics, Sept. 1969). Recent developments in drilling cheaper tunnels with ultra-hydraulic techniques or with a nuclear-powered "mole" make the tube transit idea increasingly interesting. All these technologies, however, move people to within walking distance of the central district and they also exert strong pressure for continuous availability of services.

The core of the cities of the future, therefore, will be closely tuned to the bid-asked quotations reported in the specialized markets in all other cities as well as the results of elections, changes in laws, and announcements of administrative decisions. The present computerization of the securities and commodity exchanges will indirectly, if not formally, bring about an extension of the time the exchanges function. The data processing in the multi-national corporations already goes on continuously, as is evident by the lights in the buildings around the Rockefeller Center complex in Manhattan, but there will be a hundred times more in the 1980's. It is expected also that hundreds of billions of Euro-dollars, or their successors, will be funneled through these centers seeking the highest rate of return. Weather, earthquake and reservoir data are increasingly of worldwide interest, and therefore have round-the-clock demands upon communications channels--not to mention solar observations on corona activity which yield predictions on global telecommunications noise as well as the launching of space flights. The vocations and avocations of populations in globally oriented urban



communities are likely to separate out "night people" from "morning people" and the "late risers."

As one moves away from the jetport, the harbor and the central district, the diurnal peaks, although noticeable, are expected to remain increasingly dominant. Thus, at the edge of the metropolis, even before the ex-urban countryside takes over, the human propensity to separate day activities from night activities should be virtually as complete as it is today. However, countries intent upon developing rapidly may decide that they cannot afford this underuse of capital equipment; they would conserve their accessible urban space by spreading the peak flows and converting much more of the metropolis to multiple shifts.

The rescheduling of space and time in a metropolis is a complex affair with implications that have not been thought through very adequately. Design exercises suggest that circulation space (roads, transport lines, parking, sidewalks, etc.) could be safely reduced to half the present proportion (say 12-15% of total area instead of 25-30%). Power plants, schools and offices may also be reduced by half, while floor space for shopping could shrink even more. Homes, parks, laboratories, hospitals, and cultural centers are difficult to reduce at all. Thus, the new tradeoffs between space and time would result in a city with very different appearance from those we know today. Very much improved market-like systems would be needed which allow individuals, families and larger groups to find their own optima in allocating time and income because no urban designer could find the right compromise in advance. Very likely the avocations of groups will be as important as the schedules to be met on the job.