ENERGY AND FUTURE URBAN FORM

by

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I. INTRODUCTION

This paper deals with a topic of prime importance to the future of life in American cities as well as to the continued welfare of our society, and that is the effects which a greatly changed future supply of natural energy may have on our cities in terms of land use, size and shape, transportation, and urban design. Because of rising fuel prices and an increasingly competitive world energy market marked by political turmoil between the energy-producing and energy consuming countries, very few informed persons would doubt that the next thirty or forty years will witness profound changes in the way in which we view energy supplies, in the way in which we consume energy, in the prices we pay for such energy, and in the way we regard our position in the world energy marketplace. Indeed, this process of maturing will undoubtedly affect the way in which we organize our settlements. I expect that the remainder of the century will be a very difficult and challenging experience for the continued development of our urban areas since so much of our past urban growth has been premised on a cornucopia of cheap natural energy.

Abundant cheap fuel influenced the location of activities and land uses, allowed for the rapid growth of an auto-based transportation system, and permitted the design of buildings which use great amounts of energy for heating and cooling. To reverse such habits so that less energy is consumed while continuing to strive to build a system of urban living which lends happiness, health, and prosperity to all will be a very great challenge to urban planners.

Planners must now begin to make energy use a factor in all of their considerations. This extra , added dimension may in some instances prove to be difficult but may also serve as an additional argument to be employed in support of certain "schools" of urban design which advocate increased population densities, reduced auto dependence, a renewed role for the neighborhood and the central city, and ecologically-based planning. Regardless of philosophy, energy has now become (if it was not already) a matter of crucial interest to enlightened urban and regional planners.

As a student of urban planning who has long been concerned with environmental affairs and has become increasingly aware of the necessity of Man to live within the ecological limits that his finite spaceship imposes upon him, the topic of energy and future urban form came to be a natural marriage of interests. I am very much in favor of influencing some basic changes in urban living, in hatching a new energy and environmental ethic, and in fostering the growth of emerging life styles which promise to be less energy-intensive without sacrificing those key elements which I regard as most essential and germane to a satisfying and fruitful human existence. Obviously, all the implications which an altered energy diet carries could fill a number of volumes of sociology, planning, architecture, geography, and psychology but I intend to deal here with just a few aspects of how American metropolitan areas ought (or will) begin to change from the point of view of an urban planner.

What are some of the issues I will deal with here? In the initial section I will examine the world energy market together with predicted future U.S. energy consumption and future energy availability. Along with the impact of hoped-for energy technology advancements, this shall give a picture of the coming energy state of this country and lend valuable perspective to what I will later advocate. Additionally, the extended analysis of future energy supplies and consumption will serve to dispel many of the false impressions of our energy situation which are presented in the media by the large energy corporations.

Next, I will comment on the issue of urban land use and how it influences and is influenced by energy prices. This will lead into a discussion of what basic, large scale changes should be made in land use, and how land use planning should be very closely united with transportation planning. Future urban transportation schemes will be outlined and some examples of how these concepts may support future urban design will be put forth. New (and not so new) ideas regarding the design of the Central Business District and the residential neighborhood will be discussed and some broad suggestions regarding the implementation of all these proposals will be included.

The time frame in which I am working is about thirty or forty years. That should be long enough, I estimate, to get us past what should be

the leanest energy years and be time enough to affect (at least partially) most of the changes I advocate. A longer view could not very accurately guage the impact of technological advancements, foretell such improvements which are yet beyond the horizon and still unforeseen, nor judge coming social, psychological, and political evolutions which will also play an important role in urban development.

The great majority of writers who have made prognostications about the future have been in error, it seems, since unforeseen events occur which upset their basic premises. I do not suspect that my efforts will be met with too much more success than most, although I will attempt in my writing to control my radical impulses and present a point of view which is conservative enough to be acceptable and within the realm of possibility. A friend recently wondered aloud to me whether writing about cities of the future was akin to writing science fiction. After a chuckle, I assured her that I was trying to keep my work out of that categroy by making what seem to me to be modest assumptions based on realistic extensions of present conditions and a sober assessment of human nature. Only time will tell if my judgements were correct. I hope that the reader will draw similar conclusions upon an examination of the facts.

II. AMERICA'S ENERGY SITUATION

A. Energy Consumption in the United States

Perhaps the most outstanding single characteristic of the United States in the second half of the Twentieth Century is its prolifigate use of natural energy. In this country (and others) people's lives are defined and influenced to an astonishing degree by the use of natural energy for transportation, work, shelter, and recreation as they have never been in the past, most even in the recent past. We live in a high-energy civilization filled with every conceivable power gadget and are becoming more energy conscious daily. Increasing per capita energy consumption coupled with a steadily growing population has brought us to a situation of crisis proportions as the easily obtained domestic and world sources of energy shrink and more nations compete for world energy resources. The present nature of the U.S. economy dictates that more energy be made available annually at the rock bottom prices we have enjoyed for years. Life in our cities, in particular , demands a great deal of energy, as current transportation patterns and habits are very energy-intensive. How tightly are we gripped by such energy demands? Let me outline our present and predicted energy-use levels.

Between 1950 and 1965 the total U.S. energy requirements increased about fifty per cent. This 1965 level will have grown by seventy per cent by 1980 and by 250 per cent by the year 2000.[1.] The U.S. energy consumption in 1973 was equal to thirteen billion barrels of oil and current projections indicate that by 1985 our requirements will equal twenty billion barrels. The U.S. will require over 300 billion barrels of oil between now and the turn of the century, which is more than we can likely find within our borders and about half of all possible Mideastern discoveries for the next 100 years.[2.]

Demand for electrical energy has been increasing at a rate surpassing that of the total energy demand, principally because of air conditioning and space heating requirements.[3.] The total consumption of electrical energy in the U.S. quadrupled between 1950 and 1980, while population will have increased by "only" one-third. Per capita

consumption of electricity in that period rose from 2,000 to 6,500 kilowatt hours per year. The 1980 per capita consumption of electrical energy is estimated at 11,500 kw. hours per year.[4] Thus, demand for elctrical energy is doubling every decade.

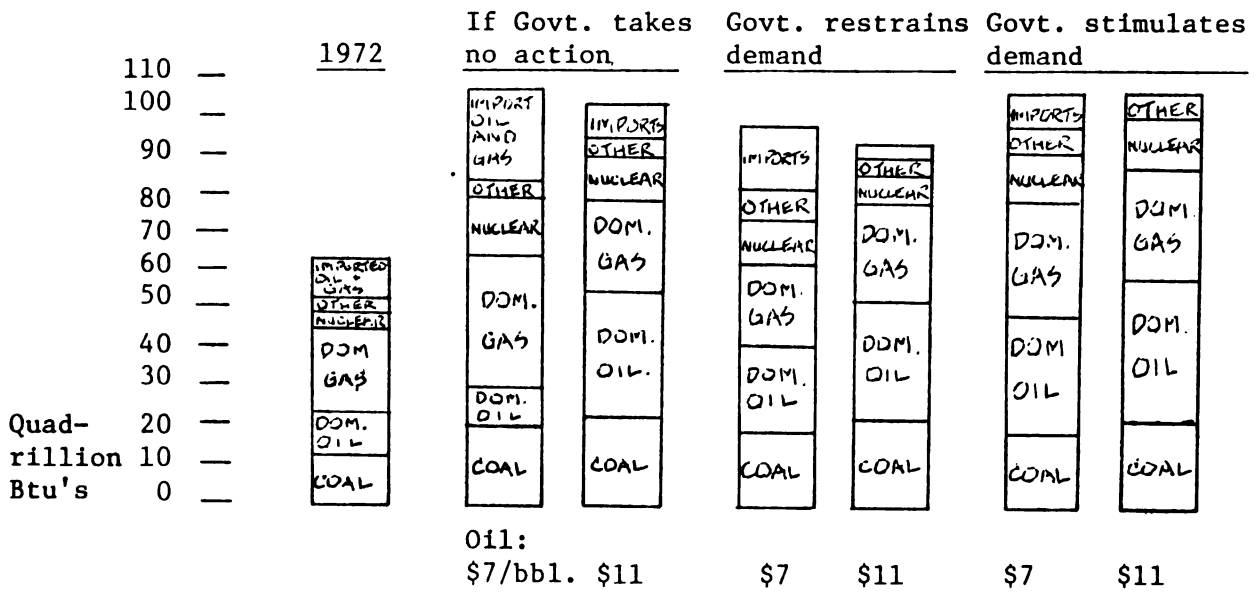
Oil and natural gas form 75% of the nation's current supply of natural energy. The supply of these two mineral in the Western hemisphere for the next fifty years is about double nature's supply, assuming the five per cent annual rate of growth estimated by the Federal Energy Administration. If oil consumption continues its recent rise, no fewer than 325 billion barrels will be needed in this country in the next thirty years. More astonishingly, if growth in demand continues unchecked, we may require 600 billion barrels more in the thirty years that follow.[5] By 1985 the total annual U.S. petroleum demand thus might be equal to using up the energy equivalent of the total potential oil reserves in Alaska every two years. The cumulative petroleum use of the U.S. by the year 2000 might be more than ten times these Alaskan reserves. Such growth in oil consumption could completely drain the conventional oil supply in the U.S. in the next fifty years. However, production of oil could "peak out" long before the resource base is exhausted. Conventional oil production ought to level off in a decade or two and certainly before the end of the century.[6]

Most recent energy use predictions have been too high because they are only extrapolations of past trends and do not take into account such factors as higher energy prices, lower fertility rates, government influence, lowered material growth and consumption, less wasteful uses of energy supplies, and the growth of a post-industrial society. But at least these predictions make us realize what could easily be the case; we are made to realize what level of energy supplies are necessary if future consumption continues past trends and patterns. The future is in our hands.

The Federal Energy Administration (FEA), making the conservative price estimate of a barrel of crude oil in 1985 to be $7 to $11 per barrel in 1985, stated that domestic oil production can be increased

fifty per cent by that date, to as much as 17 billion barrels per day. Today oil imports average six million barrels per day and are not expected to drop until 1977 , according to the FEA. By 1985 oil prices will likely be great enough to cut oil and gas imports down to the equivalent of five million barrels per day even though the overall evergy demand will have grown fifty per cent to 105 quadrillion British Thermal Units (Btu's) or higher.[7].

U.S. energy requirements are met by an array of matural sources: coal, domestic oil, domestic gas, nuclear power, imported oil and gas, hydro-electrical power, and to a very slight extent, other sources such as the sun, biofuels, and wind. A graphic breakdown of energy resources consumed (excluding hydroelectrice) for 1972 and 1985 is presented below with varying allocations of each resource in 1985 as influenced by Federal policy:



The total amount of energy available for consumption may be broken down by various general sectors of the economy. In 1968 the U.S. energy budget in quadrillion Btu's looked like this:

Sector	Net Energy Input	Gross Energy Input
Household and Commercial	13.6	16.1
Industry	19.0	21.4
Transportation	15.2	15.2
Electricity generation, utilities	14.0	----
Total	62.4	52.9

Industry is the single greatest user of the nation's energy, requiring 42% of the annual total. this is followed by transportation with 29% of the demand and by the household and commercial sector with 19%. Fuel for autos, trucks, buses, and jet airplanes accounts for 81% of the propulsion energy. when energy consumption for secondary transport related activities such as fuel refining and manufacture of transportation equipment is included, the Net Energy Input for transportation rises to 38% of the total. Petroleum provides 95% of this demand, electricity about 0.1%. Of energy consumed in the home, space heating is far and away the greates source of use, requiring 57% of the total. Other domestic energy users are water heating (15%), refrigeration (6%), air conditioning (13%), and other uses, including lighting (11%). [8.]

More than half of all U.S. transportation energy is consumed by cars. this is 14% of the total U.S. energy consumption and more than 30% of our total petroleum supplies. Automobile gasoline consumption has risen drastically since World War II for two major reasons: first, there are twice as many cars on the road today as there were in 1950; secondly, the average American drives twice as far now as in 1946, mainly because the shift of the population to the suburbs necessitates longer commuting distances to work, recreation and shopping.[9.]

Gasoline consumption, now about 100 billion gallons per year , was reduced by about only 35 million gallons per year in the last three years despite a 180% price increase. these prices are now more reflective (although still not equal to) what the rest of the world has been living with for years. We have enjoyed abundant cheap energy for years as our rapidly expanding industrial base dominated the world resource market. Now we must readjust to the realities of a finite planet.

B. ENERGY AVAILABLE

Contrary to popular belief, the world is not running our of natural energy resources. The difficulty is that with existing sources there is a limit on how quickly we can extract what is in the ground and deliver it to the consumer in usable form. Moreover, the amount of resources or reserves does not actually indicate how much oil, gas, or coal is available for consumption. Refinery capacity determines how much can be made available for sale. The desire of the oil, gas, or coal companies to mine and sell the resource varies with the price and the cost of extraction. Government taxation and leasing policy and foreign countries' development policies also play important roles in determining how much of a resource a company will or can go after.[10.]

Oil and natural gas account for 75% of the total U.S. energy supply.[11.] Only about 15% of these minerals which are consumed in this country are imported.[12.] The National Academy of Sciences predicts that undiscovered recoverable resources of oil andnatural gas, onshore and offshore, in the U.S. and abroad are considerably smaller than indicated by figures currently accepted within governmental circles.[13.] That is, world petroleum supplies may run out in 50 years, U.S., Arabs, and all.

The worldwide discovered petroleum resources may reach their peak rate of production in the 1980's even if all the constraints give way. Surely additional oil will be found but the resource base itself suggests that oil production could well reach its peak before the turn of the century. The world oil picture is thus quite likely to follow the U.S. pattern except that production may grow at least into the 1980's and perhaps a decade longer before it, too, reaches a peak and begins to decline.[14.]

The 45 billion barrels of proven oil reserves represent only about 30% of the oil in the known reserves because current technology and prices permit recovery of only 30% of the oil in a given field. Oil supply, thus, must take into account technology and price. Depending on these factors, various authorities have estimated the total amount of oil recoverable in the U.S. anywhere from 200 to 2,000 billion barrels. about 200 billion barrels is probably representative of the readily

recoverable U.S. crude oil reserves. This is about 1,090 quadrillion Btu's. The petroleum reserves of the world are estimated to be about 10,000 quadrillion Btu's.[15].

Natural gas is truely our most limited energy source. Discovered reserves will not last mosre than another decade. We may have already reached the peak of feasible gas production; if not, we will have by 1990.[16].

Coal contains roughly thirty times the energy value of our combined gas and oil inventories. So adequate are the U.S. coal reserves that we are in no danger of running out for another century. However, coal creates numerous environmental problems in its mining and burning.[17].

Electrical power generated by turbines propelled by the force of water, once a prominent source of this nation's energy , now supplies only 4% of the total U.S. energy supply.[18]. Since the majority of the nation's largest rivers are already fitted with a full complement of dams and environmentalists and riparian owners are quick to oppose any new dams, it is highly unlikely that hydroelectric power will increase in the future as a power source for the U.S.

Nuclear power , which now generates only 5.4% of the U.S. energy needs, could provide 10% of our total energy requirements by 1985 and 25 to 40 % by 2000.[19]. By 1985 the uranium demand to fuel the nuclear fission reactors will have increased four-fold. Can the uranium industry expand fast enough to meet the demands of the '80's? With the predicted rate of nuclear fission power profileration, known reserves will last no longer than another 25 years.

Aside from the uranium supply problem, nuclear fission has yet to convince a number of observers that the collosal dangers of radiation escape which it presents (and will continue to present for 250,000 years) do not negate its benefits as a power source. In additinn to the gigantic dangers posed by fission reactors, a number of scientists point out the fact that the reactors are themselves an "energy sink". That is, the first seven years of a reactor's development constitute a direct energy loss and with its relatively short 25 year life sapn, a reactor becomes much less the energy bargain it may appear to be.

The only way nuclear power can make a significant contribution to our power meeds in the 1990's and beyond is if the breeder reactor is successfullly developed. At least 15 years away, the breeder reactor, would create more irridated uranium than it uses and , thus, be able to supply fuel for all nuclear plants, lowering the cost of electricity produced. If the breeder were to be abandoned or to fail nuclear energy could prove to be a short-lived energy source -- a nuclear flash in the dark, so to speak.

Man's ultimate energy source may be a solar reaction reproduced here on earth in a nuclear fusion reactor. Nuclear fusion, which could be safer than fission, and employ virtually inexhaustible fuels, represents the most difficult technical challenge of the century. Presently, fusion only is in the experimental stage and is not considered a viable future alternative yet. A demonstration fusion reactor is at least 20 to 40 years off. If (a big "if") technologically possible, fusion reactors producing electricity could become price competitive in the 21st Century.

The development of the fusion reactor as a significant energy source should not be relied upon too heavily, however, due to the formidable technological barriers which must be surmounted for its development. Why not let the sum handle the fusion reaction and simply collect its radiated heat and light rays? Here is an inexhaustible source of energy which is produced free of cost. Our expenditures would cover the apparatus necessary for transforming the solar radiation into useable heat and electricity. This may be done in a number of ways. One method which is currently technologically feasible and quickly becoming price-competitive is known as solar collection. Water or some other liquid is circulated between two flat pieces of metal and heated by the sun to 130 degrees F. or more. The hot water is then stored for use in a space heater or may be tapped to drive and air conditioner. Electricity may be produced by use of the sun in two ways. One involves the use of parabolic mirrors to produce very hot steam that in turn drives a turbine generator. The other employs photovoltaic cells to convert sunlight directly into electircity.

Presently, both systems are relatively inefficient and extremely

costly when compared to conventional means of generating electric power. But many experts believe that the effective use of solar heating, combined with energy conservation, can reduce a household's needs for electricity to such low levels that solar generation of electric power may be unnecessary for decades. Studies have shown that solar systems can satisfy 100% and 98% of Los Angeles' heating and cooling energy needs and 45% and 92% of Minneapolis' heating and cooling needs.[20] A backup system (furnace) is needed for power during periods of protracted cloudiness but the fuel savings produced by the use of solar collectors should more than make up for this defieiency once solar collectors can be mass produced cheaply. Although the initial cost of a solar heating and cooling system is high, the initial investment is offset by the savings in costs of conventional fuels over the entire life-cycle of the building. A comprehensive economic analysis with electrically heated homes even before the recent escalation in fuel prices shows that the fuel savings from solar energy more than pay for the extra investment in every section of the U.S. except the Pacific Northwest.[21] The TRW corporation foresees a $1 billion per year U.S. market for solar heating and cooling units by 2000, resulting in a savings of more than a quarter billion barrels of oil annually. Enthusiasts of photovoltaic power believe that efforts to improve efficiences and develop a continuous silicon ribbon for mass production could reduce the present cost a thousandfold, down to $0.26 per watt. Nuclear power presently costs about $0.50 per watt. In addition to cost and resource savings, solar energy systems will not pollute the air or ground water, burn up irreplaceable resources, or threaten health and lives in the event of an accident. The National Science Foundation predicts that by 2000 solar energy may provide 35% of all the energy required to heat and cool buildings and by 2020 the U.S. may be producing as much energy from solar sources as it did from all sources in 1970.

A source of fuel and energy which has been heretofar ignored or overlooked for the most ;art is the prodction of gaseous , liquid, or solid fuels from organic wastes, otherwise known as biofuels. During degradation of certain organic materials in a closed system, the heat of combusition reaches 500 to 700 Btu's per cubic foot. Through such

a reaction a high quality methane gas may be distilled for the cost of about $1.33 per cubic foot -- about the cost of substitute natural gas as is now being produced from a naptha plant in New Jersey.[22.]

A similar concept involves the combustion in an airless chamber (pyrolysis) of urban wates such as paper, grass, wood, or sewage, and household industrial, or agricultural wates which amount to over 2 billion tons per year nationally. Such a process, hindered presently by economics, could supply 3% of the U.S. needs and have the very beneficial side effect of disposing of great amounts of urban waste which would otherwise have to be either buried or uselessly burned. St Louis is currently engaged in a program of burning its paper wates to create steam heat and electricity for a number of its Central Business District buildings.

Thus, an array of energy sources are available, but for us to produce the required amounts of energy new technologies must either be refined or newly developed. A number of political, environmental, and economic hurdles stand in the way of complete development of all existing energy resources but if these can be managed we will make it to the day when the sun can be harnessed for all the power we need.

C. Some Implications

Because it is difficult and unlikely that we may find new technologies in "old" energy sources such as coal or oil which may significantly increase our energy supplies over the next 25 to 50 years, and major advances in the generation of electrical power are generations away, it is imperative that the planners and policy makers of our society work to institute new patterns of living, building, and consuming in order that the energy which is available and affordable may be used to deliver a satisfactory level of well being for all. As stated in the preceding sections, the remainder of this century will bring decreased supplies of natural energy and higher energy prices. To combat this trend, large scale policy changes will be required, one of which may be a fundamental restructuring of the development pattern of our urban complexes.

In the past, land use development patterns have been predicated on the assumption of the continued existence of a cornucopia of cheap energy. The resultant energy demands for transportation of people and goods, together with a proliferation of buildings which squander energy for heating and cooling, has now locked us into a level of energy consumption which demands a disproportionate and debilitating amount of our personal and national resources. We must begin now to loosen the grip which our past decisions have placed us in by taking the requisite steps to restructure the existing stock of urban land use patterns, building styles, transportation modes, and activity patterns, and ensure that new urban growth generates a minimum of energy use, particularly in the sector of transportation. Changes of this sort will be very slow, obviously, because of the literally concrete nature of past development and because of the time required to change the established habits and custons of the population.

While I am confident that the readjusted energy market will produce some changes in urban form and urban activity patterns toward a conservation of energy resources, the magnitude of such transformations, the time scale in which they will evolve, thier duration, and the specific elements of the urban complex which will be affected remain a matter of educated speculation. It may just be that people

will decide that they prefer their current styles of life and energy consumption levels so much that they resolve to pay whatever the cost may be to purchase all and any resource available to forestall the alteration of their ways. While this is unlikely, in an estimation of future trends and developments the strength of factors such as consumer behavior, resource availability, resource price, technological achievements, social and demographic developments, and politics (both domestic and international) must be considered. Resource price and availability are subject to a number of outside influences. It may be that prices will continue to rise and availability will not be increased so that energy conservation becomes an essential consideration in personal and governmental policy making. Or an alternative scenario might show a vast increase in electrical availability with a corresponding drop in costs so that petroleum and coal use is greatly offset and larger supplies of gasoline remain available at an affordable price, allowing the continuation of dispersed urban activity patterns through the use of the gasoline-powered automobile. Or perhaps social trends may emerge which result in urban development patterns which serve to conserve energy, just as the "baby boom" of the 1940's and '50's, coupled with suburban expansion,worked to increase energy consumption significantly.

Based on the most recent energy resource analyses , I believe that the trend for the remainder of this century will be one of higher energy prices and decreased availability, especially for gasoline and fuel oil. Along with this will be a continued economic strain on the consumer, slowly evolving governmental regulation of energy use, and a general forced conservation of energy. Urban form will be most affected by the continually rising cost of gasoline, and the evolution of advanced mass transit systems will do little to allow the continuation of the presently dispersed and horizontally segregated urban pattern. Just about the time that gasoline price and availability reach unbearable dimensions, major breakthroughs will be recorded in electrical power generation and non-fossil fuel energy alternatives will become price competitive. By this time, I believe, the momentum toward a

more compact city will be irreversible. Even if acceptable battery powered autos are developed, I feel that the sort of unstructured horizontal growth we have recently experienced will not be revived. Just what forms will replace it, I will elaborate upon in a later section.

Planners must take into consideration more than just straightforward economic cost in their policy-making deliberations. I, for one, feel that there is a wide range of issues to be addressed in the formulation of future energy policy. This is a fundamental problem, demanding that we reassess our definition of "growth", our criteria for individual and collective well being, and our ideals of life. Many Americans have reached a point of consumption saturation while numerous others have yet to achieve a decent standard of living. For the poor to bear the costs of energy savings, the necessity of which has been largely created by those who have profited in the past, would be a grave injustice.

We must reject the "more is better" ethic, replacing it with one of "enough is best", otherwise all that our efforts at increased energy efficiency --small cars, mass transit, industrial re-engineering -- can achieve is to buy five, ten, or perhaps fifteen years of additional time. Thereafter, the demand for energy will resume its former rate of exponential growth and son confront us with the same problems we had sought to escape but merely deferred and intensified. What is needed is a willingness to make rather fundamental changes in our economy and our values. As Barry Commoner pointed out, the increased consumption of energy does not necessarily mean that we live markedly better. Are we better off, say, because trucks instead of railroads haul freight? Or because we live at greater distances from our jobs and drive bigger cars?

The "future is now" because of the long lead time required to develop new, cleaner sources of energy and to re-mold those factors which dictate our consumption patterns so that we may achieve large and significant changes. If we are to balance U.S. energy supply

and demand in the decades ahead in an environmentally acceptable manner, we must make the basic policy choices and decisions now. We face the imperative that Edmund Burke stated well almost two centuries ago when he wrote:

> "The public interest requires doing today those things that men of intelligence and good will would wish, five or ten years hence, had been done." 24.

The role of government -- at least in terms of providing leadership -- will need to be more sharply defined. Urban and regional planning must be recognized as having greater importance, be given a more prominent and influential role in the governmental mechanism, and expand in scope and power. New governmental programs will have to be initiated if the changes needed are to be achieved.

Also requiring scrutiny is governmental policy in regard to the so-called free market system. Presently there is such a plethora of governmental regulations, tariffs, and subsidies involved in the market system that it is hardly the free system it is billed as. Many governmental constraints actively encourage energy use and maintain artificially high energy prices to the detriment of the greater part of the population. I question whether the market system can wisely plan for the future, whether it can develop the required new energy resources by itself, and whether it can lead us out of our energy straits without increased governmental assistance. The free market system brought us the non-returnable bottle and the glass building. Will it take them back? Unless governmental policies are refined so that they encourage energy conservation and work to establish realistic fuel prices, it is doubtful that free enterprise can act to use energy more wisely.

Those who attempt to depict a wisely planned conservation-oriented society as coerseive or stagnant are drawing a false picture. There is nothing coersive about a society in which buildings do not leak heat; in which people get to work by rapid transit rather than by driving cars; where short trips are taken by high speed rail rather than by flying or driving; and in which the products of society are built to be durable and recyclable. It is a matter of re-ordering priorities

and channeling investments into energy saving activities rather than into more power plants and refineries. Such a society need not be stagnant. Recreation, education, performing arts, farming, health care, research and development, and high technology would be some of its growth industries.

Finally, in addition to the constraints of cost and environmental preservation on our growth in energy production should be added a moral constraint. If all the peoples of the world are eventually to enjoy an adequate level of well-being, we will need to adopt a new ethic which regards waste as a form of crime. For if we continue a self-indulgent, disposable society where the cycle continually is to dig, burn, build, and then discard, we are stealing from our children and grandchildren the planet's resources. Infinitely better and more rewarding benefits from the oil we are currently burning may well be discovered by the petrochmical industry in the future. Our energy appetite and its consequences should cause us to question the whole structure of our material-oriented, energy-intensive pattern of industrial production, our wasteful urban forms, and at bottom, the basis of our civilization.

III. EFFECTS OF EXISTING URBAN FORM ON ENERGY CONSUMPTION

In this section I will briefly examine those elements of the modern urban complex which the largest portion of energy consumption may be attributed to and which are within the realm of influence by the urban planner. The conclusions which are drawn from these observations will serve as a basis for the changes in urban form and structure which I will present in the next section. Of course, a great deal of energy use is attributable to sources such as industry, inter-city transportation, and home appliances, which are outside the realm of the planner's influence, and to sources such as heating, cooling, and lighting which can only be marginally affected by planning decisions. But a full one-quarter of the total U.S. energy budget is within a sector which may easily be affected by urban form, and that is transportation.

More than half of all transportation energy, 14% of the total U.S. energy consumption, and more than 30% of the toal U.S. petroleum demand, goes to fuel automobiles alone. Most of this expenditure takes place within urban areas. There are twice as many cars on the road now as in 1946 and the average American drives twice as far now as in that year. This increase in driving and gasoline consumption is in direct correlation with the dramatic changes which have taken place in the nature and form of our cities in the past thirty years and has become a significant element of our annual energy demand.

Energy demands for the heating and cooling of buildings, which requires about 20% of the U.S. energy budget, are primarily the responsibility of the architect but the planner may also play a significant role in energy conservation in this sector as his decisions critically influence the architect's designs. For instance, general development guidelines drawn up by planners for architects' use in the design of buildings in a redevelopment project may dictate building orientation, size, and even the percentage of wall area taken by windows, or a general guideline regarding energy efficiency in architectural design may be included.

Energy demands for both transportation and building heating and cooling are influenced by land use. This broad topic includes such subtopics as the arrangement of activities within the urban area, the number and type of structures on a particular parcel of land, and the interrelationships of the various elements of the city (transportation, industry, commerce, housing, and open space) with each other in respect to geographical location and generation of human activity patterns. It can be shown that a direct correlation exists between the general nature of the land use pattern and the transportation energy demand for various cities of comparable size, as well as between the land use model and building heating/cooling requirements for cities in similar climates. Land use is definitely within the concern and persuasion of the urban planner and, thus, will be the primary topic of concern of this paper.

A very interesting and revealing analysis of the variations in energy consumption produced by different residential land use intensities was created by the Real Estate Research Corporation.[25.] Six types of communities were examined along with six neighborhood housing types, and the relative costs in terms of annual energy consumption and developable land were estimated and compared. The five types of communities were:

I.) Planned mix (20% each of housing types a - e);

II.) Combination mix (housing mix of 20% of each of types a - e of dwellings, half located in planned unit developments, half in traditional subdivisions);

III.) Sprawl mix (20% of housing types a - e);

IV.) Low-density sprawl (entire community is single family detached housing, 75% on a traditional grid pattern and the rest clustered. Typical subdivision development.);

V.) Low -density planned (75% type b, 25% type a);

VI.) High-density planned (forty per cent high-rise, 30% walkups, 20% townhouses, 10% clustered single family houses. All dwelling units are clustered into contiguous neighborhoods, much in the pattern of a high-density new community.)

The six types of neighborhood housing analyzed were:

a.) single-family conventional

b.) single-family clustered

c.) townhouses clustered

d.) walk-up apartments

e.) high-rise apartments

f.) housing mix (20% each of 1-5)

To no one's surprise, the report concluded that high residential densities require less energy for heating, and that high densities and the "planned" communities stimulate less auto use. More specifically, "planning" alone can save nearly 14% of the total energy consumed, but "planning" combined with increased density can save up to 44% of the total. In addition to greater energy economy, higher densities also have the benefits of generating 20 to 30 per cent less air pollution (due to reduced auto use) and are more "efficient" in the use of land. With equal populations, over 50% of the land in the high-density planned community remains completely undeveloped, whereas all the land is at least partially developed in the low-density sprawl community. The high-density planned community also uses only half as much land for transportation as does the low-density community.

The comparative analysis of energy consumption (in billion Btu's per year) for each of the six community development patterns is detailed and accounted for below.

Type I: 86% of III; the difference reflects the variation in gasoline used in auto travel. Natural gas and electricity consumption are a function of housing type, with apartments consuming less than single family homes.

Type II: 92% of III; the difference reflects the variation in gasoline used in auto travel.

Type III: Approximately 3,281 billion Btu's per year.

Type IV: 92 % of IV; the difference reflects the variation in gasoline used in auto travel.

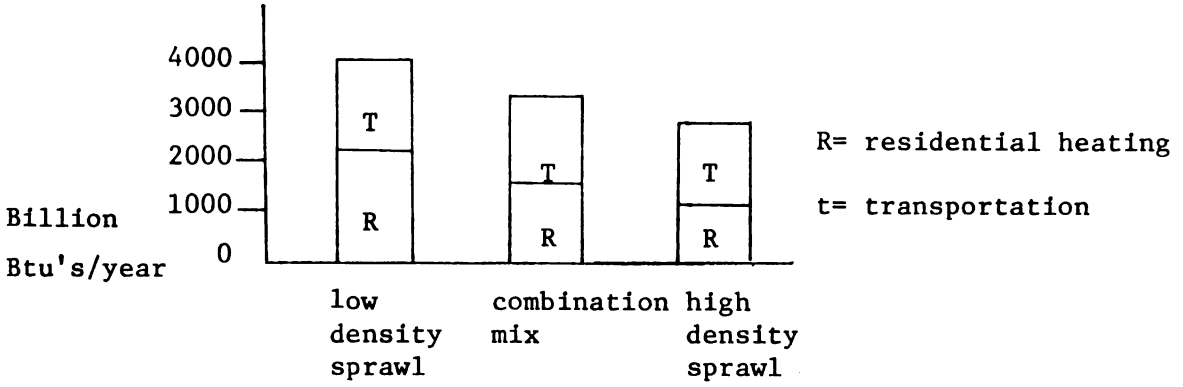
Type V: Approximately 4,060 billion Btu's per year.

Type VI: 56% of IV; the difference reflects variations in residential power consumption by housing type and the decrease in auto use in high density areas.

It can be seen that the high-density planned community, which has only 10% of its housing stock as single-family detached units,

and in which all dwelling units are clustered into contiguous neighborhoods, requires the least amount of energy for heating, cooling, and transportation purposes.

In graphic form, the energy demands of the low, medium, and high consumption community types appear thus:



The reasons for the lowered levels of energy use in the higher density, better-planned communities are not difficult to guess. First of all, auto transportation demands are reduced in both frequency and length by locating points of numerous trip destinations (work, school, shopping, recreation) closer to points of trip origin (primarily home and work), thus making walking and bucycling feasible alternaive transportaiton modes; a single trip may serve two purposes, such as work and shopping or work and recreation; the operation of public mass transit is made feasible and economic because sufficient numbers of residential units can be located in close proximity to bus or rail stopping points while numerous trip destinations may likewise cluster around other stops, a characteristic not possible with low-density, scattered communities; the distance between origins and destinations may be shortened through the reduction of "machine space" (land area devoted to auto circulation, parking, and service) per developed land parcel through the increased use of a vertical arrangement of land used and the consequent shifting of transportation modes from auto to public transit.

This last point about "machine space" should not be overlooked.

In Los Angeles and Detroit 70% of the downtown area is devoted to the automobile.[26] Thus, when you drive your car in from a low-density area, what you find when you arrive at this supposed center of activity is, primarily, just a lot more roads. More roads generate more cars which generate more roads, ad nauseum, until people get sick of so much driving, of having their lives dominated by a machine meant to serve them, and of paying for increasingly expensive gasoline.

The reasons behind the energy economy of heating and cooling higher density communities is also elementary. It is easier to heat and cool the smaller volumes of air encompassed by apartments and townhouses than the space created by single family dwellings. Additionally, when units are cuddled together shoulder to shoulder and top to bottom the amount of exterior surface exposed to the elements is reduced from what it would be if the same units stood independent of each other, keeping the units warmer in the winter and cooler in the summer.

This brief observation of the major uses of energy which are amenable to change by urban planners illustrates the importance of wise land use planning, the necessity of a more intensive use of developable land, the need for reform in zoning law, and the value of a widely accepted public mass transit system. When energy for transportation propulsion was cheaper and more easily available, the inefficient use of land, the waste of travel time, and the pollution of the atmosphere were more easily lived with. But now that people are coming to realize the adverse effects of the rampant use of the auto and its ramifications in terms of urban development , community liveability, monetary cost, and energy demands for transportation and space conditioning a shift is very slowly beginning to be made in people's mentalities regarding what form an urban complex should take.

This readjusted conception of the interrelationship of the entire spectrum of city systems will begin to be manifested in the future forms of urban development and redevelopment. The changes will be slow and probably not painless but the themes which will soon emerge will probably dictate to a great extent the nature of our urban form in this country for the next century. In the following section I shall elaborate on

what I foresee as the general systems description of an urban complex of twenty-five or thirty years hence which is evolving or has evolved into an acceptable state of energy economy given the predicted levels of energy cost and availablity together with slightly revised social and cultural norms.

IV. FUTURE URBAN FORM

A. Goals and Objectives

A revised urban form based on ecological and social planning principles will be in opposition to many (but not all) of the basic concepts around which our present cities are built. Planning has played but a minor role in guiding the development of nearly all of our urban centers and land use has been arranged by the forces of the so-called free market system. Thus, to a great degree we are still living with heavy industry along the river, freeways through the hearts of residential neighborhoods, bedroom communities in suburbia, and warehouses ringing the downtown, which nearly closes up completely after six in the evening. Urban design and planning was completely unheard of until just recently and still the tools which are needed to carry our the goals of such endeavors reamin to be developed in this country to a degree whereby planners are able to effectuate their schemes with success on anything more than the smallest of scales in most cases.

Moreover, there were no goals or objectives for the growth of a city until recent years other than the basics of sanitation, public protection, and the right to use one's property as one wished. Relatively recent developments in controlling and guiding urban development have arisen but have tended to be piecemeal and short term with little or no comprehensiveness and even less hope for a solution to the larger problems which beset cities. Given the status of urban planning in this country, its relation to the decision-making elements of the government, and the nature of land ownership rights under the Constitution it is not surprising that greater gains for planning have not been achieved.

Aside from the fact that planning since World War II has had little or no political clout or comprehensiveness, it has suffered as greatly from the fact that it also has been largely lacking of any underlying goals or philosophy other than the fragmentary

and mutable suggestions of the social scientist and the heavy-handed influence of the economist and engineer. What the field of urban planning requires now and our cities desperately need is a strong new philosophy around which can be clustered the developing knowledge of the social sciences and the pragmatism of economics and engineering. The goal of such a philosophy would be to create an urban environment which is more responsive to human needs, which draws itself more into harmony with environmental demands and limitations, and which successfully combines form and function.

I, therefore, propose three "new" goals for urban design:

1.) Build an economic purpose for urban growth which stresses the long-term costs of maintaining equilibrium in the built environment over the short-term costs of development.

2.) Develop a large scale view of the community as a set of associations in which the diversity of community needs is met not by supplying ever increased mobility but by building greater diversity into a tight knit arrangement.

3.) Institute an aesthetic built on form as a natural adaption for survival.

Each of these purposes requires some change of attitude on the part of industrialized nations. The first of these, a revised economic attitude, seems to fly in the face of all our established notions about supporting urban growth, whether held by a capitalist or a socialist society. An unfortunate short-term solution to the energy problems which have beset us (and will remain with us for some time to come) would be to hold to the old attitude and continue the old methods of supplying increased demand with more oil drilling, more strip mining, more nuclear plants and so on in a desperate attempt to keep a wasteful system running. A new attitude is required that will make long-term conservation of our natural resources a governing purpose for design.

The second goal requires a change in the way we achieve the

associations that make up a community. The basic components of any association of buildings are those that allow us to be housed, to work, and to shop in some balanced combination. The automobile has allowed the past two decades of urban growth to space these basic functions very far apart. The new cities of the southwest U.S. are spectacular examples of arrangements comprised of large and specialized segments of housing, commerce, and industry. Access to all three functions requires that people migrate daily, often over great distances. The development of rapid, public transportation promises only to maintain the segregation of activities and people that now characterizes our sprawling cities. An attitude is now called for that allows diversity of activity in near proximity to become a governing purpose for new growth.

The third goal requires that we change our prevalent attitudes about what constitutes good building design. The governing criteria must include response to the cyclic forces of nature for the design of an adaptive architecture that will embody a new aesthetic. The building of cities must be consciously organized and limited within the environmental capacity to transform energy and the human ability to comprehend scuh transformations. If each of the three design purposes of economics, community, and aesthetics were restated in terms responsive to the natural envoronment, the result would be a transformation of our existing cities and a different mode of new growth resulting in the conservation of energy and our natural environment.

Based upon the three general goals stated above, I have compiled ten objectives for future urban form. As stated, they are rather modest but if they can be met they will be the source of important changes in urban life and our national energy situation. The objectives are:

1.) Reduce the use of energy for intra-city transportation.

2.) Reduce the use of energy for the heating and cooling

of buildings.

3.) Increase the integration of metropolitan functions within single communities.

4.) Reduce segregation of mutually compatible land uses.

5.) Greatly decrease urban sprawl.

6.) Revitalize the role of central community facilities; renew decaying inner-city neighborhoods.

7.) Improve accessiblity to needed urban functions and services for all members of the metropolitan area.

8.) Develop a means of intra-city transportation which is more socially, environmentally, functionally, and aesthetically acceptable.

9.) Heighten the sense of neighborhood unity and identity.

10.) Instill greater concern for environmentallly valuable elements such as rivers, lakes, woodlands, wetlands, etc.; develop a better interface between such areas and adjacant land uses.

The fulfillment of these objectives in whole or part will do much to slow the expansion of energy consumption as well as to make our cities more pleasant places to live. The remainder of this paper will be devoted to the development of fundamental strategies which may be employed in the hope of achieving the objectives.

B. General Form and Structure

After having discussed the goals and objectives which I feel should guide future urban development and redevelopment, I would next like to lay out in a systematic manner how the city should be regarded for study and what general options are available for urban growth. Four basic prototypes shall be portrayed, their working elements explained, and the pros and cons of each discussed. From these four prototypes one will be recommended as a model for future urban growth, as an ideal which currently existing cities can attempt to evolve toward and which new cities may use in their planning process. Energy economy will, of course, be the outstanding judgemental characteristic but an attempt will be made to take other economic and social factors into account as well. From this general framework details will be worked out regarding the development of the subsectors of the city such as the transportation network, the central district, and the residential neighborhood.

For analytic and descriptive purposes a city must be pictured as an abstract entity consisting of a number of human activity patterns and service networks embodied in a range of physical patterns of land use and building arrangements. The list of human activities and physical arrangements exist in a continuum, the particular arrangement varying from city to city, and within which any given urban agglomeration may be located. New York, Los Angeles, and Ann Arbor, although each is vastly different from the other, can all be analyzed and described in common terms of human activity and physical arrangement.

"Form" is the term I shall apply to the physical pattern of land use, population distribution, and service networks.[27] "Structure" describes the spatial organization of human activities and interrelationships. The form and structure of New York City are very tight while those of Los Angeles are generally very loose. Most cities in this country lie somewhere between these two extremes but may also contain limited instances of both very loose and very tight

form and structure. No city is entirely homogenous in its arrangement; irregularities occur due to economics, topography, and human nature.

Form and structure are neither antonyms nor synonyms, but, rather, are complementary of each other; each describes a different concept and each operates on different ecological levels. Urban form (the arrangement of buildings) influences urban structure (the human activity patterns) but there exists also a reciprocal arrangement whereby the urban structure tends to stimulate and direct the growth of the urban form. It is highly unlikely that a city could have a very "tight" form (a number of land uses piled closely together with a large, varied population) and still exhibit a "loose" structure (human activities and interrelationships spread disjointly across a great area). Instead, a person's activity pattern in a case such as this would tend to be rather tightly circumscribed and limited since it is likely that most of the people and services he would require could be found in a relatively small geographic area. A person living in Manhattan, for example, would hardly have need to leave the island to participate in most of his usual activities, while a Los Angeleno often has to take his car to buy a loaf of bread and practically always has to drive to work.

Urban form and structure are described by their particular continuous measurement scales. Form is the degree of dispersion or concentration of urban artifacts and functions while structure is based on a specialization-integration continuum of human activities. The dispersion-concentration measure indicates the tendency of certain functions to spread our over the city horizontally while other functions pile up vertically. Housing, for example, may be located both near the center as well as on the outer fringe of a city, while the stock brokers or fruit wholesalers tend to concentrate near one another for business purposes.

A major force behind dispersion is the propensity to seek

private space values, a push which has been amplified by automobility and the increase in long distance communication technologies. Concentration, on the other hand, indicates close knit physical linkages at the expense of private space. This may reflect purposeful choice, for example in office shyscrapers, or simply the lack of any other choice, as is often the case for low-income and minority residences. The increased use of the auto and telephone indicates an attempt to have the best of both worlds -- seclusion and togetherness -- at different points in time since both have attributes which are to be valued. Concentration increases one's choice and possibility of human interaction and avails one of more and varied services while dispersion allows more privacy, space, and individuality. In choosing a residence, a person makes the decision as to what attributes he wishes (or needs) to maximize and what payment he is willing to make to enjoy those characteristics of residence which his chosen domicile will not inherently afford him. Residential location is most ideal when the benefits native to both dispersion and concentration are simultaneously optimized and external payment (i.e. time and money spent driving the car or riding the train) is minimized.

The specialization-integration continuum of urban structure deals not so much with the buildings of the city but with the human activities which the buildings allow. Urban structure is a concept which charts the patterns of human movement in the city over a cyclic period of time, such as a day or week or month.

The question arises as to the scale at which a degree of integration should take place among the various specialized activities and functions of a metropolitan urban complex. Specialization implies interdependence, with more or less coherent organization at one or more levels for industrial production as well as for urban areas. Some pivotal questions need to be addressed in this regard. Do the elements of a city fit together only at the metropolitan scale no matter what their size, or are there limitations of scale for certain everyday urban functions? Is

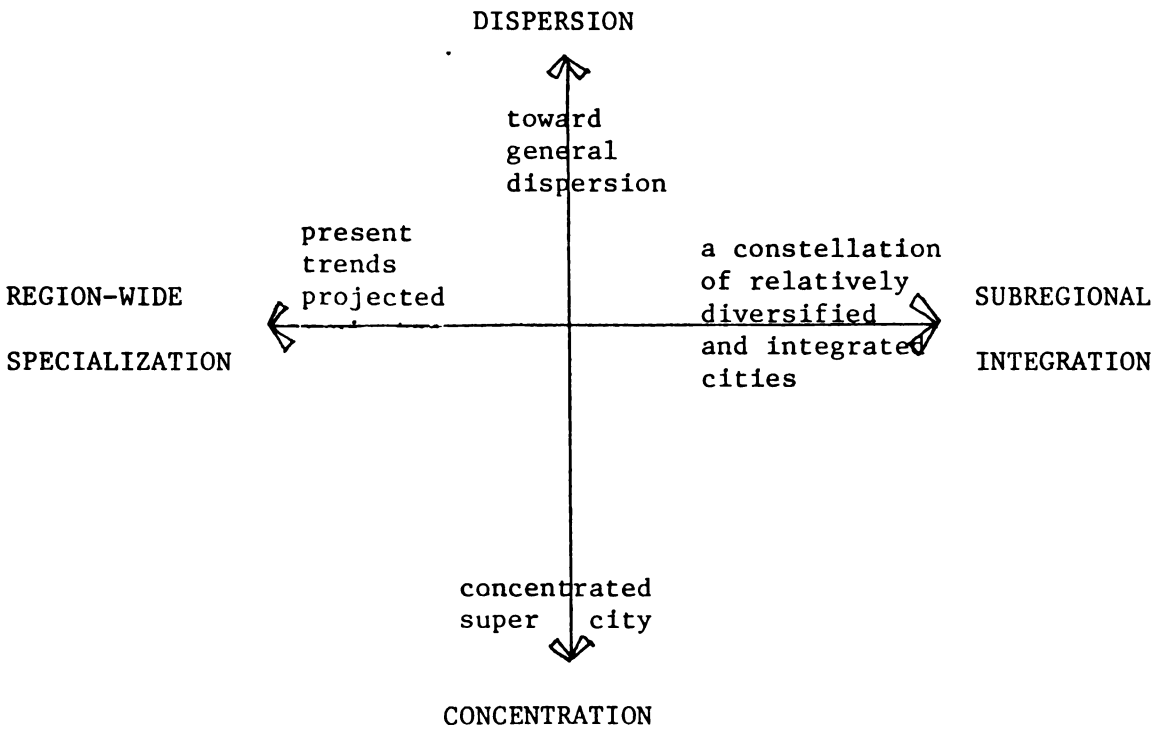
the metropolis essentially a single diversified market for housing, jobs, and leisure time facilities or is relatively balanced and integrated development feasible or desirable within metropolitan subareas?

One hundred years ago there existed very little functional integration at the metropolitan scale; people lived worked, shopped, and found companionship and recreation in a relatively small area of the city. The neighborhood was a viable and identifiable entity which served most of the daily needs of its residents since transportation to other sectors of the city was largely nonexistent.. Today, on the other hand, most urban dwellers are compelled to move all about the city to fulfill these same needs, as improved transportation means have allowed the segregation of land uses and the enlargement of activity patterns. But there are signs of the roots of a rebellion against this life style typified by suburbia and freeways as many new housing developments sing the praises of the wide list of other activities offered within esy reach of the resident's apartment such as tennis and swimming, shopping, a "community center", offices and retail trade, educational facilities, a public transit system, and a park. The balcony is becoming the fire escape of days past where adults may share conservation and drink with others.-- maybe even their next door neighbors. The big back yard (full of grass to be cut and dandelions to be plucked) is no longer seen by all as the goal it once was. A move is underway to achieve a concentration of certain often-sought activities (home, work, shopping, recreation) while reserving the opportunity to take advantage of other, more limited and specialized activities offered only at certain points in the metropolis (live theatre, special interest clubs, specialized recreation activities). People may be able to have their cake and eat it, too.

Four Future Urban Prototypes

These exists a wide variety of hypothetical choices for future urban structure based on the variables influencing form and structure but there are a certain number of limitations to future forms on all existing and future communities, not the least of which is the availability and costs of energy. The choices range from the metropolitan Super-City (a single system with highly differentiated and interdependant parts) through various transmutations to a group of smaller urban communities in a regional setting, each providing for most of the ordinary economic and social needs of an approximate cross-section of the urban population.

The dispersion-concentration and the integration-specialization continuums present four alternative paths for the development of the city, and they may be portrayed graphically in this manner:[27]



A projection of present metropolitan trends would result in region-wide specialization with most functions dispersed but with a push toward greater concentration of certain functions in central cities. Such trends are not entirely stable and may well shift to one of the other alternatives. General dispersion would mean region-wide specialization of certain functions but a considerable degree of subregional integration might be induced. The patterns of a concentrated super-city would exhibit a strong tendency toward specialized sectors for different functions. Form and structure in this arrangement would both be very "tight", land intensely used, accessibility good and private space at a premium. The last general option -- a concentration of relatively diversified and integrated cities -- would present the possibility of a range from moderate dispersion to moderate concentration with cities of differing size and character within a metropolitan region. Such an arrangement would best accomodate the diversity of life styles normally found in a large population.

Each of the alternatives should be measured by how well it meets human needs (housing choice, job accessibility, class and race patterns, individual opportunity, social relations, family welfare and privacy, etc.). But the costs of each must also be measured (costs of housing, transportation, redevelopment, open space; broad social costs such as enforced dislocation, destruction of existing values, waste of resources, etc.).

A number of questions exist as to the feasibility and practicability of establishing a super-city with region wide specialization of functions and activities. One must wonder whether such region will turn out to look like a big traditional city with business in the center, industry on the fringe, and a succession of neighborhoods segregated by income and race. Can such a pattern be extended over a large area even though it works well on a small scale? Problems will surely arise with regard to functional and demographic integration and the unification and coordination of governmental entities.

All this leads the observer to wonder whether the metropolis is necessarily a single organic system with highly differentiated parts or whether it is merely an agglomeration of smaller, internally complete systems which interact only in a narrow band of functions. There seems to be a scale beyond which functional integration is not possible nor desirable and at which subregional integration is necessary. New York appears to have reached that point, along with several other cities of the world, and further attempts to enlarge upon the existing corpus are generally counterproductive to functional stability and the quality of life of its citizens.

Metropolitan unification as one huge city seems unlikely for a number of reasons. The present trends appear to be toward specialized sectors and communities rather than subregional integration; social divisions between old cities and new suburbs are sharp; locational specialization of employment and business enterprise, recreation, open space, housing type and cost, and urban leisure time activities has created a pattern which poses obvious problems of extended cross-commuting, of limited housing choice, and critical tax base discrepencies; class and race conflicts, along with tax base discrepencies, are leading to deepening political conflict between central cities and suburbs which makes metropolitan unification more difficult unless it is imposed by state or regional government; and, finally, the class conflicts between suburb and central city, which appear to have been exacerbated by the force busing of children to accomplish racial integration of central city schools, will serve to strengthen the suburbanites' resolve to remain independent of the central city unless the Supreme Court decides to include suburban schools in the busing plans, a move which seems unlikely at best. [28].

Although the American metropolis has in certain ways been moving toward a vast city style strucutre with highly differentiated and interdependent parts, and there has been no conscious countermovement to encourage a greater degree of functional balance and self-containment within subregional sectors, the actual metropolitan unification under a single government does not appear to be a liklihood for

the reasons stated above. Even though metropolitan unification of all services and functions is not down the road, there is no good argument against the subregional specialization of certain selected functions, for we do not really know to what degree and for what specific purposes the entire region is necessarily a single system.

For instance, certain functions which used to be integrated on a city-wide scale are now showing trends which favor some form of subregional specialization. It was assumed in the past that certain activities could only be encompassed to a significant degree on the metropolitan scale, e.g. special consumer demands which brought people to central districts. If a tight multipurpose center has the stimulating and universal advantages claimed for it by central city saviors, then a large metropolitan region should probably have several such centers to serve the potential demand.

The critical questions regarding subregional integration vs. metropolitan segregation are the ones stemming from the spatial systems of residence and employment. Even today these two systems seem to be very much in geographic congruence. Census data and recent studies show that the number of employed persons who manage to live and work in the same subregional sector may be surprisingly high, considering the limitations of choice in the housing market.[29] It seems that technology has not yet overcome the friction of space for the metropolitan commuter and that, given the proper housing and service opportunity, people may choose to live in the same geographic sector of the metropolis as they work.

The possibility of greater functional integration of activites within metropolitan regions is bolstered by the fact that the present trends in housing may shift toward a somewhat wider balance of population in both outlying areas and the central city as a result of court decisions on zoning cases and through influences from state and federal government. If planners take advantage of such trends, the nature of the form and structure of the city may be in for some dramatic changes from the way we know it today, resulting

in (among other things) a great savings in transportation energy.

Alternative Directions for Urban Form and Structure

There appear to be four basic developmental alternatives for the future form and structure of American metropolitan regions and cities in general: (1.) the continuation of present trends, (2.) decentralization based on the auto and modern communications technology, (3.) centralization and higher densities, and (4.) constellations of self-contained communities abutting a revitalized central city.

Should future urban development assume a similar nature to that of the last twenty years (Alternative 1), with a continued emphasis on suburban living and sustained economic growth of the suburbs to the detriment of the central cities, the problems which presently hound healthful metropolitan (particularly central city) development will only be exaggerated. The current difficulties of accessibility will find no solution as the automobile will remain the only viable form of transportation in spite of soaring fuel costs.

Some metropolitan mass transit will be developed through massive federal expenditures but it may not find sufficient acceptance by the middle classes, which it requires for true success, since points of origin and destination will continue to be largely limited to the cyclic commuter's trip between home and work. The multi-functional centers of residence, service, employment, and recreation will not develop should present trends continue. Only a private vehicle can properly serve the widely scattered points of interest which form the nature of taday's activity patterns.

The installation of public mass transit linking existing centers will surely serve to strengthen them, and with some additional

aid functional nodes may develop at stopping points along its route, but the urban form and structure which is being enhanced is not the most desirable one available. Transportation energy costs will remain very high with such a pattern despite the overlaid transit system because of the continued dominance of the auto and the unfeasibility of walking and bicycling to most destinations.

Additionally, there are costs of other sorts inherent in the present trends. Social and political schisms will not be lessened, there will likely remain an inadequate choice of housing and services, and costs will continue to rise, particularly for housing and transportation. But most critical to the topic of discussion here is the fact that the energy demands featured by the continuation of present trends are simply unacceptable.

The second urban development alternative, general decentralization and dispersion of activities, is based on the misguided premise that the auto and modern communications can alleviate any difficulties which may be induced by the separation in space of urban functions. Proponents of such a pattern place highest value on the suburban home and the lifestyle it entails, support the "community without propinquity" model described by Melvin Webber[30.], and hold the Los Angeles area as a model for the future. Without malice, many "decentralists" favor the concept of allowing the central city to decay, not sinking any more public funds into it so as to ripen it for proper redevelopment on a grand scale at some appropriate point in time.[31.]

From an energy standpoint, this is the most unacceptable prototype available. Transportation energy use is pushed to its maximum, as any chance of viable public mass transit is crushed, the auto is required to go almost anywhere, bicycle and pedestrian transportation alternatives prove unacceptable for all but a very limited number of trips, and the trips taken by auto prove to be greater in length tham those in any of the other three developmental alternatives. The sprawling expressways, designed to handle the

voluminous number of cars at high speeds, succeed in only generating more cars which reduces their swiftness and requires more land and a greater separation of functions. Additionally, heating and cooling energy demands are greater in the decentralist model since it implies that residences be single family detached units and not the more energy efficient apartments.

Central core vitality is effectively destroyed by this scheme and subregional centers fail to achieve true success since only a partial serving of the needed functions is offered, the remainder available at some points a few minutes drive away. Instead of subregional integration of functions and services, a complex chain-like system of overlapping catchment areas is developed for daily activities, extending outward indefinitely. Technology, while overcoming distances, is not really amenable to creating the kind of community which provides contacts and responsibilities that cut across special interests creating common ground and stimulating nutual adjustment and integration. Specialization, without an effective framework for integration will not benefit the common interest.

The third alternative, a concentrated super-city, would be in many ways the opposite of the preceding model. The super-city requires metro-wide integration of most all functions in the various subsectors, high or medium population densities throughout its limits with a halt to scattered fringe development, high population densities at the city "core", apartments in the suburbs, mass transit which serves all areas, and a marked decrease in reliance on the auto. Pedestrian enclaves in the city would be required and surrounding open spaces would be preserved by eliminating suburban sprawl. Land would be intensely used and all buildings would necessarily be multi-story. Land use would be segregated both horizontally and vertically, with many central area buildings containing a vertical integration of retail shops, offices, and residential units. (This theme will be further elaborated upon in the section on central city architectural innovations.)

This would be the most acceptable solution from an energy standpoint. Many daily activities and functions would be within walking or biking distance and practically all would be accessible by transit. If the city were planned and developed properly there would be no need for a private car at all except for occasional forays out of town. Additional energy savings would be scored in the category of residential heating and cooling due to the great number of apartments.

Perhaps the ultimate example of a concentrated city is that proposed by George B. Dantzig and Thomas L. Saatz, entitled "Compact City".[32] Designed for a population of 250,000, the entire city would be embodied in a structure 8,800 feet in diameter and 242 feet in height. Apartments on eight levels would form the peripheral rings of the city while the core would contain shops, manufacturing, offices, educational facilities, hotels, and other public facilities. Most internal transportation would be by foot, bicycle, or mechanized "people mover". All air would, of course, be circulated and cleaned by mechanical means. There would be extensive use of mechanical vertical circulation (elevators and escalators), fixed rail transit, and an automatic delivery system for small objects.

Dantzig's proposal is completely unfeasible when considered in light of our social, economic, and political environment, However, many of the ideas presented, especially those regarding vertical and horizontal movement of people and goods, the need for greater proximity between home, work, shopping, and recreation, and his total-system planning approach may be useful when applied to new developments in existing cities on a smaller scale. Also interesting is his emphasis on the city as a place which should foster the personal interaction of a large, heterogeneous community of people.

The creation of a super-city which actually works and is not just an overgrown urban area (dare I suggest New York?) will need supporting policies at all levels of government and will require

a strong and effective regional governmental body, as the demands of the super-city will extend far beyond its corporate boundaries. This city would require huge amounts of state and federal assistance, for the costs of its transit system and central city redevelopment will be very high. Due to the high degree of functional and social specialization in the various sectors, structures and subareas would have to be carefully designed to fit particular activities.

Finally, there are a number of broad social costs and dangers inherent in a city of such high population densities which are not easy to measure or quantify but are unarguably present. Even the best of designs cannot fully alleviate the tensions brought on by such a mass of humanity living in close quarters with limited provisions for privacy nor can the cityscape provide the spiritual and bodily refreshment offered by communion with natural surroundings, which appears to be so essential to Man's psyche. And what is the fate of the numbers of people who cannot afford spacious living quarters nor periodic travels to the countryside? Such human costs must be carefully considered before such high density schemes are advocated for larger proportions of the population than already are forced to deal with them presently.

The fourth developmental alternative proposes a system which is somewhat similar to the central city/suburb pattern which exists today with one important distinction -- each separate governmental entity would be much more self-contained and diversified, having a greater integration of the range of functions formerly offered at the metropolitan level. That is, within each community there would be a much greater selection of housing, recreation, shopping, and employment than currently is offered, and in each community there would be developed a commercial/office/institutional center somewhat similar to that which exists (or used to exist) in the central city.

Attempts would be made to integrate within each community as great a variety of the desired range of services and functions as feasible without creating a diseconomic overlap and duplication.

Certain services which serve a limited market and which could not be sustained only by the population of a single community would have to continue to draw from more than one community, perhaps from the entire metropolitan region. But an end would be put to the "bedroom community" as we know it today, or any other type of community for that matter which contains only a limited scope of activities that are needed daily to the exclusion of others.

The old central city might remain strong for region-wide functions and highly specialized activities but would generate relatively less employment and have a more balanced population with mixed densities and dwelling types. The central city CBD will decline in relative but not absolute importance. The cities of the metropolitan region would be of a more uniform size than today, would be rather close knit in a regional network, and would be of a much more compact nature. Densities would not need to be high but a perponderance of medium residential densities, say in the neighborhood of ten to twenty dwelling units per acre, would be needed to allow transportation modes other than the auto to be feasible and attractive. The great amount of land which is saved by these higher residential densities and reduced raodways could be devoted to open space for recreation.

The design of the metropolitan CBD could utilize many of the vertical layering concepts discussed by Dantzig (and others) and which are currently being revived in the centers of many of our more advanced urban areas. Including residential units in an area which for so long has been held as the exclusive domain of commerce would do much to enliven the area, attract additional entertainment and retail sales, and ensure that the center of activity and interest.

Suitable housing for all classes, ages, and race groups would be provided in each community at mixed densities and related to the varied employment opportunities in each area. Thus, one would be much more able to find his choice of housing near the location of his employment. In each community would be developed a distinct

commercial/office district similar to that of the central city CBD but of a somewhat different architectural style and with a greater ratio of commercial-to-office functions than the CBD. With residential and employment areas integrated, commuting between communities would be low and many activities would become accessible by foot or bicycle. Many of the auto trips which did have to be made would be of a smaller average distance, and mass transit as we know it today would not be so necessary. Arterial transit would be available between city centers and other points of high activity,and subarterial transit would also be provided within each community,but there would not be such a great demand for movement in the morning and evening between far-removed residential areas and centers of employment. Time, money, and energy could be saved and put to uses more humanely beneficial. Each particular city would, hopefully, participate actively in the regional planning process with an increased local citizen interest. In all, there would be a greater concern for accessibility, diversity, and traditional urban values. as a balance of city and nature, privacy and opportunity would be made more easily available.

Clearly, this fourth alternative is the one I favor. It is also the pattern which our metropolitan areas seem to be moving very slowly toward, as the suburbs grow in population and add a diversity of functions. The central city CBD no longer acts as the commercial center it once was now that many stores have relocated to outlying centers. Many suburban dwellers rarely find it necessary to go into the central city, since almost all of their needs can be satisfied elsewhere. But there are many important changes necessary before the metropolitan area becomes a multi-centered city. Employment and housing patterns continue to be out of step and the various economic classes continue to be widely segregated. The suburbs must gain a much greater diversity of functions than they currently contain and their housing densities and variety must be increased. Although it is unlikely that our metropolitan areas will be able to undergo change to the degree

necessary to achieve all the ideals of this development alternative, I firmly believe that much can be done to move in this direction and, thus, build the framework for a much more healthful long-range development of our metropolitan areas than that which is possible given the continuation of the present pattern.

C. The Important Role of Transportation

The system of transportation which is to evolve in our urban areas may be the critical element of the city of the future, influencing greatly the working interdependence of the city systems and the overall quality of life. Transportation influences and is influenced by the land development pattern. As such, it will play an instrumental role in determining whether or not the tight-grain, multi-centered pattern advocated here will be feasible and acceptable, for for land may be used only as intensively as the means of access and circulation allow. Similarly, the way in which zoning, taxation, and other public and private forces cause cities to grow and redevelop will determine which transportation technologies will be most suitable.

In any case, transportation policies and land development policies should not be pursued independently of the other. The city must be seen as an organic whole. One system should not be seen as either master or servant of the other; they each must be conceived with the other in mind. In the past, transportation systems have simply been fitted to the pattern of land development, designed to serve the existing origin-destination network. this has not led to the best use of land nor has it produced an efficient circulation system fro all city residents. Land has been squandered, functions spread widely apart, travel time increased, and energy costs have soared.

In this section I will propose an overall system of transportation based on developable technologies which may realistically be fitted to the present urban pattern in incremental stages to not only meet existing circulation demands but, more importantly, to allow and encourage what I believe to be the needed fundamental changes in urban form. One of the goals of the system would be energy economy by three means:

1.) reduce the level of energy-intensive transportation modes, namely today's auto,
2.) reduce the overall per capita demand for circulation by encouraging the development of a land use pattern which
3.) allows the widespread use of alternate, low-energy transportation modes, especially walking and bicycling.

(I should note here, also, that energy economy should not be the sole criterion for judging the performance of a transportation system. The ultimate goals of the system should be to provide affordable circulation to all city residents between all desired points so as to make all urban opportunities equally accessible. Energy diseconomy , high operating costs, user limitations, and poor land use patterns caused by the current system are what create the inequalities of access we now suffer with.)

Problems with the Existing Transportation System

Today's urban transportation system consists mainly of private autos which are supplemented by public buses and, in some of the older, larger cities , by fixed-rail mass transit. Walking and bicycling are practically negligible. The problems and shortcomings of such a heavy reliance on the car have been written about profusely by many others but allow me to restate them briefly here.

First of all, cars use extensive amounts of precious natural energy to haul around two tons of machine and 200 pounds of passenger. They waste money for gas, repairs, and massive infrastructure. These miles of road also waste valuable urban land. In Los Angeles 35% of the total land area is used for transportation or its related facilities. Sixty percent of its CBD is devoted to the car. In Detroit that percentage is 64, in Washington, 43, in New York, 34. [33.] It's getting so there is as much area devoted to getting there as there is places to go. The spent fuel fills the air with chemicals which damage our lungs and eyes, discolor our buildings, stunt our plants, and rob us of many beautiful vistas. The quick and easy

movement offered by the car has been a prime factor behind the massive sprawl our cities have suffered in the last thirty years. Distance is now measured in minutes, not miles,and there is no longer any compulsion to locate homes, stores, or factories much nearer each other than the price of land dictates. Neighborhoods and communities have taken on entirely new meanings as propinquity is no longer a criterion for community.

The freedom and privacy offered by such mobility has its price, however, as people have become slaves to their wheels, and many aspects of neighborliness, diversity, and convenience which once made cities so attractive have been lost. Gone also is that sense of human scale in cities; gone is much of the charm inherent in a series of enclosures and open spaces which a person could experience best on foot at a walking pace; and gone from cities to a great degree is the appreciation a person could feel for the details of his environment and his relation to nature. Not all urban residents can take advantage of the car's mobility, either. The elderly, the young, the poor, the handicapped are practically trapped unless a friend offers a ride or unless they are brave enough to use public transporation, which offers rather limited service. Some of these walk or bicycle, which offer varying degrees of opportunity but still hold many restrictions.

To the enlightened urban planner, the car's effect on land development patterns have been most unctuous. Such freedom of movement generates a very "loose" urban pattern. Facilities tend to be spread all over the map and land development is inclined to be the least intensive, influenced more by price than access. Residences and services are designed to cater to the auto more than the person, and the greatest problem in any new development is not how to handle the buildings themselves but where to park all the cars. Thus, the car is not conducive to intensive urban development at all. In those areas where land prices and certain intrinsic factors combine to create intensive development, streets are usually squeezed to a minimum, traffic circulation is then very poor, and

other modes of moving people are able to gain a foothold. Liberated from the need to handle the car, architecture and planning may turn to serving the person, often with pleasing results. If such high density nodes can be achieved more frequently throughout the urban pattern, I believe the problems of access to facilites in the city will be lessened greatly and urban life improved in several respects, not the least of which will include a savings in transportation energy.

The Evolution of an Improved Transportation System

Future urban transportation systems will concentrate more on moving people and less on moving machines, resulting in an energy savings. A variety of modes will be offered, although the modal split will not be less than 75% in favor of the auto in 1990.[34]. The auto will remain the dominant mode but each year will witness a shift from the auto to other modes, resulting in an overall more balanced system. The Stanford Research Institute concluded that "a single, all purpose urban transportation system, capable of satisfying all needs for all urban dwellers, is not expected to emerge within the foreseeable future, if ever." [35]. What is required in the future is a thirty ot forty year strategy of overlapping developments capable of producing harmonious changes in urban form and transportation habits which would include such measures as improved autos, more compatible highway development, support for conventional transit, new transit system development, personal rapid transit systems, and the development of systems combining auto and rapid transit alternatives.

If a new family of systems is to gradually supplant the auto it must combine a variety of characteristics to meet a diversity of needs: (1) low speed distribution for short distances, (2) high density systems within centers of urban activity, (3) fast, high capacity systems to serve the major portions of trips between home and employment, retail and recreational concentrations, and (4) collector systems capable of functioning efficiently between low-density housing developments and rapid transit stations, shopping centers, or suburban industry. Increased automation will be important.

Origin-destination time will be more important than speed between stations and, thus, it will be essential that an entire family of systems be available and that they interface with each other properly, allowing a traveler to complete his entire journey with a minimum of walking and waiting. Service, convenience, and other such factors will be more influential to the ridership of transit than fares.

Along with major advances in the conventional auto and bus, such as battery power sources or hydrogen fuels, researchers foresee three new generic types of transit modes: (1) that for local area travel of two or three miles, which constitute a majority of our daily trips, (2) that for extended area travel of relatively long trips between local areas, centers, satellite towns, or a combination of these, and (3) that for major activity centers such as a CBD, air terminal, university, or industrial park.[35.]

Local area travel systems would include the presently-developed dial-a-ride bus and a public auto system (PAS). These publically owned vehicles, used for short trips, would seat two or four passengers, have a top speed of 25 miles per hour, and be parked at conveniently located stations throughout the neighborhood where they would be picked up and returned. Operational access and billing would be handled by a computer-coded key of some sort.

Circulation in major activity centers (MAC) could be facilitated by the introduction of any of a family of so-called "people movers" -- small automated cars or fast pedestrian conveyors, both of which would operate at speeds of not more than 15 miles per hour on grade-separated rights-of-way. In Central Business Distircts a MAC system could serve to circulate people between outlying parking lots or transit stations and employment or shopping areas. The system could be designed to fit in tightly with existing structures, perhaps to even pass through the interiors of buildings, and work closely with the interior vertical circulation systems.

Extended area travel would utilize both of two systems: (1)

area wide network (NET) and (2) fast transit link (FTL). A NET system would offer direct service between higly diversified origin-destination pairs distributed throughout the urban area at speeds rivaling those achieved by an auto on an uncongested freeway. Three subclasses of the NET system are envisioned and these differ primarily in the manner and extent to which vehicles can be routed through the system but also with regard to land requirements, technical difficulty, and costs. All three would employ small automatic vehicles, special guideways, and stations. A NET system would have several advantages over the present auto/express-way system including increased safety, lessened land requirements, less air and noise pollution, and less aesthetic intrusion.

The NET-1 system, the simplest of the three, would only have the ability ot route vehicles along a guideway forming a closed circuit. Area wide networks would be formed by using numerous loops in interfacing and intersecting patterns. NET-1 vehicles would hold 4 or 12 passengers. Technology for this system currently exists.

NET-2 will use four-passenger cars and have the ability to route a vehicle between any pair of stations within the entire route complex. Travelers will avoid the delays and burdens of transfers at intermediate points in their journeys. Although the costs for a NET-2 system are considerably higher than those of NET-1, the service improvements are significant.

NET-3 would have all of the capabilities and features of NET-2 plus the capability of using dual-mode vehicles of a variety of sizes and types. Cars will be able to operate at low speed on neighborhood streets as well as being propelled on the guideway as NET-2 vehicles. The principal advantage of NET-3 is that travelers who can drive and who have access to a dual-mode vehicle can make their entire journey, from origin to destination, in a single vehicle. NET-3 is more nearly ideal than either of the other NET versions from a service viewpoint. It would offer virtually

all the advantages of the auto and would offer some services that could not be obtained from automoated highways. On the other hand, the technological and financial problems of NET-3 are formidable.

FTL systems are conceived to meet, at least partially, the desire of travelers for high speeds (two or three times as fast as NET) and short travel times. FTL's are primarily for travel within and across the relatively compactly developed portions of a metro area but may also accomodate much longer trips generated by moderate to high densities of development. Their use would be especially attractive for long trips between major activity centers, e.g., between CBD's of contiguous communities, betweeen CBD's and airports, in urban corridors, and as links to satellite communities. Although the concept itself is not new (the B.A.R.T. system is a current example of this style of transit) there are numerous advances yet to be made in technology and application.

The development of an area-wide transit system of any type is a costly, time consuming effort and , thus, needs to be approached in an incremental fashion. Corridors ought to first be decided upon to link present and anticipated centers of activity, and development should proceed first on those with the greatest demand for linkage. Later, additions may be made to the basic skeleton. Provisions should be made to ensure proper interface with major activity center systems, existing transportation facilities, and the fabric of neighborhoods. Also, planning should anticipate coming technological advancements in hardware and allow for the incorporation of new features into "old" systems without undue disruption or cost. For example, a NET-1 system should be designed to eventually accept conversion to NET-2 or NET-3 status.

Along with such sophisticated mechanical means of transit ought to come a much less glamorous but nonetheless important development, a network of exclusive bicycle paths safely separated from mechanically powered vehicles. While bicycles will probalbly never prove to be an essential commuting mode in this country, with

proper facilities and encouragement their use could certainly reduce the number of short trips which must be made by car for a good part of the population. They could easily serve as means of access to transit stations, neighborhood retail centers, schools and community facilities while providing exercise and relaxation to riders. In high density areas, bicycles' use could become a very critical circulation mode whose use we cannot afford to overlook.

Effects of Future Urban Transportation Systems on Urban Form

Transportation has historically been the prime determinant of urban location and form. The prospects for a deterministic role of the former magnitude in future urban development is unlikely, howerver. Other factors, especially amenity factors, will predominately influence future urban growth. The urban pattern, nonetheless, will continue to be influenced by transportation.

The chief effect on urban form that will result from a shift from the auto to other transportation modes such as the train, the bus, or a NET system will be a return to higher intensities of land development, especially in key nodal areas as directed by current development and the evolution of the transportation network. The predominance of the central city CBD will be diminished somewhat with the advent of strengthened secondary centers of activity in outlying sectors of the central city, in the first ring of suburbs, and in satellite towns. These centers will include a major activity such as retail sales or education as well as supportive supplementary activities as offices, residences, entertainment, restaurants, and public institutions. Diversity and heterogeneity will be the keywords. The result will be a multinucleated urban form. Access between such centers will be good, strengthening thier importance, increasing the amount of development within walking distance of the centers, and further unifying transporation and land use.

Transporation technology influences how land is used since

it determines the degree of access available to a given point in the city; the greater the access to a point for large numbers of people, the more it pays to develop the land intensively. With increased development intensity comes added activity, usually resulting in a demand for residential quarters in proximity. Thus, the tramsporation technologies employed in the future will do much to determine whether or not the goal of functional diversity in a localized area can be accomplished.

The auto has done much to segregate land uses. By providing equal ease of access to most points in the urban area, it has caused much leveling of land values and encouraged the city to grow in a sprawled, scattered pattern. Activities could be widely separated because they were so easily accessible to each other. It was possible to live miles from a grocery store, miles from recreation, and even more miles from employment. Moreover, the space required for auto circulation and parking required that uses be spread out simply to make room for all the cars. Thus, we have bedroom communities in suburbia, the vast suburban shopping center, and the deterioration of the CBD.

Transportation modes which increase the channelization of traffic and do not require parking spaces at the riders' destinations will do much to intensify land development around their stopping points. This is especially true of fixed-rail systems which have a somewhat limited number of access and departure points and, thus, handle many people at these stops. Land values soar near these points as commercial and employment functions attempt to take advantage of the good accessibility and riders attempt to shorten their travel by secondary mode from the station to home by living nearby. This has taken place in San Francisco where property values have risen near every one of the B.A.R.T. stations; the Yonge St. subway in Toronto has ignited a $10 billion development explosion along its line.[36] Just as the car spreads development, the train directs it. Decisions of route and station location

thus become significant in determining community development and form.

Somewhere between the car and the train are the bus and the NET systems. The bus, with many access and departure points, allows service to dispersed development but at the same time is inefficient except for relatively short trips or as a collector for a faster, more direct mode. The NET-1 and NET-2 systems, which demand a modal change between the station and destination (even if the mode is walking), will tend to increase land use intensities near their stations but to a lesser degree than would a train. The NET-3 system offers such ease of access that proximity to the station would be much less critical and the land use effects might be similar to those generated by the car with two important differences: (1) there would still remain a desire to live or work near a guideway access point and (2) less land would be needed for circulation and parking.

Therefore, if increased gasoline prices result in a demand for improved public transporation, if bus service is improved and fixed-rail systems (including a NET model) are implemented (or upgraded) there very likely will be a trend toward the development of secondary nodes of commercial and office activity surrounded by townhouses and apartments at principal stops along the transit system. Land will be much more intensively developed and a wider range of functions available at these centers than is now the case with non-residential activity areas.

In central areas there will probably be a layered arrangement of shops, offices, restaurants and theatres, and apartments. MAC systems will speed people between office buildings, stores, transit stations, peripheral parking lots, and other points of activity. (Cars may be banned entirely from the CBD.) MAC systems will serve to magnify the influence of a point of high accessibility by extending the range of what would normally be pedestrian activity. The joint impacts of MAC and NET or FTL systems can stimulate

enormous concentrations of activity at discrete sties, which the auto does not.

Development will be in concentric rings from transit stations, perhaps even utilizing the air rights above it, in contrast to the strip development encouraged by the street. Residential neighborhoods will include a much greater percentage of townhouses and low-rise apartment buildings to facilitate service by bus, foot, bicycle, and NET-3, as well as by car. Convenience shopping centers ought to be located within one-half mile of all residences, and other, larger community centers should be accessible by bus. Grade schools should be within three-eights of a mile from any residence and junior and senior high schools and colleges should be on bus or NET lines.

Overall accessibility to required daily functions should be increased by the added diversity encouraged at the new or redeveloped urban centers. In time, when residential neighborhoods become compact enough many activities which usually require a car (or at least a bus) to get to may be accessible by foot or bicycle. Less land will be squandered on massive freeways or wide arterial streets. Neighborhoods will be affected positively rather than negatively by being near a transit artery. The city will be more accessible for those who cannot drive and, in some cases, for those who can, too. Above all (and if nothing else) a great deal of natural energy will be saved for better purposes.

D. THE CENTRAL BUSINESS DISTRICT AND THE RESIDENTIAL NEIGHBORHOOD

In this section I will discuss planning and design improvements aimed at conserving energy in two urban subareas, the Central Business District and the residential neighborhood. Changes in building arrangement, bulk, size, and design can go far to create energy savings in heating and cooling as well as transportation. Although many of the improvements which are available at this scale enter the realm of architectural design, there are a number of fundamental planning principles to consider. The decisions of planners have profound effect on subsequent architectural design and , thus, should be carefully made. To this end, I will outline a few basic improvements in the planning and design of these areas. To many Americans, some of the changes I will put forth will not be immediatly (if at all) acceptable. However, observation will show that many of them are already taking root, and some foresight may help persuade the reluctant to see the bits of wisdom in the ideas.

The Central Business District

Although the Central Business District is, from an energy standpoint, a fairly efficient use of land and transportation facilities, there remains room for improvement. Architectural and transportation innovation implemented in the CBD will tend to bolster the role of the core of the city and strengthen the CBD as an anchor for the city transit system. A vibrant and vital city core will induce medium to high density residential development at its periphery and act as a magnet, generally pulling inward new development. The higher central population densities it fosters facilitate the acceptance of mass transit alternatives. For these reasons, I am going into some detail to examine CBD design innovations and advocate their acceptance.[37.]

The downtown should become the regional center where cultural,

educational, medical, financial, and other institution, businesses, and government are tightly clustered. There should be a reintroduction of residential life to the city core along with the recreational and social activities that will keep its going around the clock. To help keep the CBD "alive", it should be designed for people, not cars. Thus, new consideration should be given to the use of the street and to the movement of the pedestrian. Walking in the city center should be an enjoyable experience, to be appreciated for itself. Design can make it so.

The first principle of proper activity center design is that there must be a variety of activities and land uses in a concentrated area. This can best be accomplished by a vertical layering of uses within single buildings. For example, the first and second floors may be retail shops, restaurants, and theatres to attract the pedestrian. Above these may be offices, above these, apartments, and then a club or restaurant atop it all. Throughout most of the world the varied activities of urban life have taken place in complex, interlinked structures in the centers of cities. Commercial enterprises and residential life have been traditionally juxtaposed in the same building. Mixed use patterns have the merit of convenience for the people who use them, save transportation time and energy, and are supported by the logical association of interconnected activites.

Valuable interior building space may be utilized more economically through ideas such as a midblock shopping arcade. Small interior courts open to the sky or covered by glass will stimulate pedestrian interest and increase retail frontage on ground level. Subterrarian levels should not be ignored, either. All of these ideas will make the core a more interesting place to be.

The second principle is that the pedestrian should be well taken care of..The design principle to accomplish this is termed the "Access Tree" by Rai Okamoto.[38] This is an analogy between urban organization and systems in nature. The "roots" of the "tree" are

the transit system, the "trunk" is the elevators and escalators within the buildings, and the "branches"are the interior passageways, the second level pedestrian system which links buildings, the second level mechanical people mover (or MAC) system, and the sidewalk. This is similar to the principles of personal circulation embodied in the early planning achievements of Grand Central Terminal-Park Avenue and the Rockefeller Center. It posits a rational organization of buildings related to horizontal and vertical transportation systems, expresses the potentialities of clustering tall structures where access is convenient, and contains a sense of economy of space and the possibiliites of diversity of scale in an urban setting.

The pedestrian portion of the "tree" may be the key element of any multilevel scheme. Properly planned, of stimulating design, forming a natural pathway between one point of dense concentration and another, the pedestrian system may constitute a delightful terminal link in a hierarchy of urban transportation. This organically whole circulation system, in addition to taking advantage of the nodal imperative of a transit system, may serve by its capacity to move people from transit door to office door, to determine to a good degree the form and bulk of the activity areas it supports. Essentially, it recognizes and takes advantage of the importance of the mechanical movement systems in relation to urban form.

The Residential Neighborhood

Since there exist a variety of style of residential sectors in any given city, I will not write as if all were alike, but will, rather, speak in general terms about the nature of the neighborhood, praise goods points which may be found and critize the bad. In certain instances I will cite specific examples, but will keep in mind that all neighborhoods do not possess those

particular characteristics.

What features are desired in a house and a neighborhood by most Americans? First of all, there are the basics of security, privacy, sanitation, and shelter from the elements. People need to be safe in their possessions and self, they need to be able to escape from others' intrusions and have an abode for their family alone, There must be hot running water, garbage service, and proper toilets, and heat in the winter. These are essential but are lacking for still too many Americans.

Beyond these are needed adequate living space for each member of the family, a secure, individual sense of domicile (the archetypal sense of home), some private open space, room to entertain friends, and peace and quiet. These are provided (or not provided) to varying degrees according to what sort of dwelling one lives in and where it is located. The suburban house usually attempts to optimize these within the buyer's budget, for they are the added comforts which people will pay for. With a big yard, free-standing structure, individual house number, large rooms, and private garage, the suburban house provides quite a bit of each of the above.

However, given the current design of most apartments, townhouses, and inner-city houses, these factors are usually lost. No wonder. Such dwellings are usually designed with the poor and/or transient in mind. They are seen as temporary quarters or simply poorly designed and constructed on very tight budgets. Such economy can be appreciated only by those who can afford to pay no more. But as the single family detached house prices itself out of the reach of even the middle class and as the miles of suburban road come to be seen as a hindrance rather than an asset, there will be reborn a kinder image of the townhouse and apartment. When costs of heating and cooling a big house become too weighty on a budget, the compact, sheltered design of other types of dwellings may be appreciated more fully. Now is just

the time to deflate the bloated image of the single family detached dwelling and to convince designers, planners, city officials, tax officials, and residents alike to reconsider the number of amenities which may be offered by a properly planned and designed residential community of townhouses and low-to-mid rise apartment buildings. The tawdy image of these dwellings, so well earned today, can be erased by building them with a new image and purpose in mind.

With proper design, I am convinced that an apartment or townhouse can almost match the suburban house in all of the amenity factors listed above. There are a number of superb European examples available and a growing collection of American achievements, as well. In the ways that an apartment or townhouse falls short of one's desires for living area, individuality, private open space, or quiet it can redeem itself in other ways. Energy costs are reduced significantly, maintenance costs and effort are cut, accessibility may be increased, neighborhood and community factors may be enhanced, and security may be increased. True, there are some people who will never settle for a townhouse, no matter how well designed when they can buy a house in suburbia or in the country, but for a great number of prospective homebuyers a satisfying alternative is available if only a few preconceptions, financial factors, and design constraints can be altered.

From an energy conservation standpoint I advocate a dramatic upsurge in the number and quality of apartments and townhouses built in the next thirty years. These should be located in comprehensively planned sites, in the older parts of central cities, in the suburbs, and in new towns. Efforts should be made to provide secure, spacious, comfortable, individualized apartments, including in the design provisions for recreation facilities, shopping, community facilities, landscaping, car shelter, a transit station, and bicycle and pedestrian ways. As large

areas of the central city grow aged, sites of appropriate size can be obtained. Buildings over three stories in height should be few in number and limited to the childless and those with infants. Necessary population density can easily be achieved with low rise buildings. All dwelling units should have either direct access to a private yard or an ample balcony. Buildings should be well insulated for sound and heat, place to take advantage of solar radiation, and have provisions for the use of alternate energy sources such as solar collection or central trash burning for electrical generation.

Properly designed, planned, and implemented, the urban neighborhood can become just that again -- a neighborhood. It can offer the advantages of diversity, interest, community, convenience, safety, and hominess as well as energy conservation without sacrificing the desired amenities of privacy, individuality, or comfort. A challenge is upon us, and it will require imagination, conviction, and confidence to rise to the occasion.

V. IMPLEMENTATION OF CHANGE

Planning for change and actually bringing it about are two entirely different things, the latter being considerably more difficult and too often not discussed in conjunction with the other. It is easy to understand why, though, for implementation is replete with pitfalls, uncertainties, and obstacles. The scope of change advocated here will be most difficult to accomplish in the necessary time frame for it involves a reversal of a considerable number of forces presently moving in the wrong direction. Such momentum is difficult to arrest when it is propelled by social mores, personal habits, legal doctrines, and institutional custom.

Certain aspects of the evolution to a more energy conservative urban form will be accomplished more quickly than others. Influencing the rate of change will be the flexibility or permanence of the element in question and the price of energy. Auto design may be changed in just a few years, transit systems may take a decade or more to build, but land use change will be a very gradual process, extending over a number of generations. Indeed, many of today's buildings may last longer than two or three generations and some facilities longer yet. Present rights-of-way create still more enduring committments.

The force of the present most capable of influencing the future is man's conception of human settlements. What happens to cities in the near future will be a result of the continuation of the past and of existing influences which will only be felt two to four generations from now. The more distant future, however, will depend much more on man's conception of future action and his ability to implement it.

It may turn out to be quite a close race between our ability to adapt and the advent of new fuel sources which prevent prices and scarcity from reaching truely painful proportions. As stated

in the initial chapter, discovered natural gas reserves will be exhausted in a decade, petroleum production may "peak out" in the 1980's, some authorities suspect there may be only enough recoverable fuel for nuclear fission reactors to last us until the 1990's, although the supply of coal could last another 200 years. Will the nuclear breeder reactor, nuclear fusion, or large scale solar power be developed in time?

It appears that considerable change will have to had been affected by 1990 or 2000 to be of any avail. By 2010 or 2020 solar power and an advanced form of nuclear power may be relieving the pressures brought on by soaring oil and coal prices. This is sufficient lead time for many major improvements to be made in transportation systems although building and land use change will lag behind. By the time new technology is able to bring energy prices back from the brink of unbearability, however, the movement toward a more compact city will be irreversible and land use patterns will continue to become more energy conservative. Legal, tax, and zoning factors which influence land uses must begin to be altered immediatly. Auto design has laready begun to change but advances must continue through the 80's and 90's. All cities over about 70,000 population should at least have bus systems by the early 1980's, and the larger SMSA's should now be formulating plans which will result in more advanced transit systems capable of reaching completion by at least 1990. For some programs, such as comprehensive transportation plans, immediate action is needed due to their great importance to the entire metropolis. In other instances, such as downtown redevelopment proposals, preparation for dealing with problems may already exist.

The agents for directing the major programs of change will be public bodies, the Federal,State, and local governments, since most of the essential innovations require either massive, long-term investments in the public sector or alterations of laws. Experience has shown, however, that the government (especially at the Federal level) does not move quickly on matters of debate.

When things go wrong in a highly developed technology top-level decision making becomes impossibly difficult . It is better that we learn to make as many desisions as possible for ourselves: the changeover from the habits of "cheap fuel" to the habits of "expensive fuel" has to be made by us long before it can be confirmed by government. It will, therefore, be necessary that a good deal of independent stimulus arise from concerned individuals as well as from private organizations which can be made to see how they can profit from investing in energy conserving technology, structure, or real estate. It will be necessary that the public and private sectors work cooperatively, for the government can not do the mammoth job itself and private companies can not afford to make the needed investments without some government aid and some changes in statutes and taxation. Some very helpful steps have already been made at all three governmental levels but much, much more remains to be done.

Agencies of control, particularly at the city level, would have to establish certain long-term policies to coordinate the efforts of the numerous groups affecting urban development. Several such policies could be as follows:

1.) Encourage continued metropolitan agglomeration.

2.) Begin to construct a generalized grid of channels for transporation, adapting its interspacing and alignment to circumstances, but aiming at raising accessibility throughout the area as a whole The grid should provide for many kinds of flow and have a hierarchy of its own -- that is, lines of circulation would be differentiated with respect to the intensity and speed of their traffic.

3.) Peaks of activity and density should be encouraged, but in sharply defined areas, not in rings, whose density gradually declines from the center. The development of two or more centers to rival the CBD would be encouraged. These centers could embrace a wide spectrum of metropolitan activites.

4.) A wide variety of activites, of accomodations, and of structural character, dispersed in a fine-grain pattern

should be encouraged. Once the concentration of special activities and the arrangement of higher densities in centers and along major channels has been provided for, zoning and other controls should be employed only to maintain the minimum grade needed to preserve the character and efficiency of the various types of use and density. Large, single purpose areas should be avoided.

5.) The outward spread of the suburbs should be limited through tax, zoning, and sewer controls to a predetermined time frame and to only those land areas which are ecologically suited for urban development.

6.) A sustained effort should be made to rebuild older, deteriorating areas

7.) Efforts should be made to retain or acquire a system of linked open spaces of generous size that pervade the urban area.

Except in the very special cases of Rockefeller Center, Grand Central Station, downtown Montreal, and a few others such as Philadelphia's Market St. East, implementation of urban development schemes planned with and integrally linked to rail transit has been elusive. Questions of long term ownership structure, legal responsibility, and development cost sharing ratios usually destroy the legal, tax, and financing benefits between public and private sectors' programs and policies that make such plans appear economically feasible in the first place. The highest priority should be given to developing legal, tax, and financial mechanisms to permit the effective integration of urban public transit with complex new strucutres. It is through such integration that coherent and congenial experience in the city center is possible.

In the U.S. the problem of actually producing a well articulated and well designed family of transit must inevitably involve concepts and strategies of joint development; that is, development in which private and public interests intermingle and contributions

are made from both sides. The private sector can only be expected to participate when it will materially benefit in some way, such as through reduced capital costs, improved depreciation potential, increased potential value, lower assessments, or reduced taxes. These are exchanged for the commitment of capital, management talent, land resources, and the determination that is found in private enterprise at its best. Some joint development strategies are slowly and painfully being worked out in cities, states, and at the federal level on a case-by-case basis. What is needed is a defined national strategy, one with real estate investment and tax realities, to induce private investment to join in joint development projects with public authorities. The design concepts and development models are available. The trick is to tailor the necessary laws, regulations, and economics to our political and social system.

Another critical matter in this regard is the stimulation of a more comprehensive understanding of the three-dimensional character of cities, incorporating connections between enclosed spaces and access to it. Land must be forgotten as a basic resource in cities to which all institutions of finance, ownership, and regulation are tied. In its place, space, enclosed, usable space, must be considered the critical element. Today, as it has been for centuries, land controls urban financing. Mortgages are based on land and improvements thereon. Parcel assemblage for construction generally requires purchase of land. Access to parcels is almost universally conceived of principally in terms of roads at ground level.

This preoccupation with land, with the two-dimensional base in which building are anchored, has caused a predominately two dimensional concept of cities. If this technologically and economically outmoded attitude can be broken, possibilities for more convenient and more successful urban clustering will be evident.

One of the very few examples of liberation from the restrictive concept of land is also a very ancient one. Condominium ownership, usually reserved for residential space, recognizes the inherent value of space as an entity. The condominium apartment which does not generally include land ownership can be mortgaged; and its value is not directly dependent of the land on which it rests. It is worth considering the importance of this form of ownership and financing of urban space as an alternative to our conventional land dominated basis. It would permit segments, levels, in fact layers of space to be separately owned. It would even allow the complex interpenetration of public and private ownership to occur as needed, and where appropriate. But condominium ownership is only one possible new conceptual basis for legal and economic formats that would assist implementation of desirable urban design concepts.

In the future, planners should give increased attention to controlling the development of the city infrastructure, its utility lines, street patterns, and location of vertical lifts such as elevators and escalators. These should determine where, how much, and how little can be built. It is being realized that the capacity of the enclosed environment can be planned, located, and sized long before construction begins. Through this strategy, urban areas and suburban districts may be planned without unduly influencing the future appearance of specific structures or even the time frame in which they may be built. With the rise of metropolitan planning bodies, the ability to regulate the extension of sewer lines may become the most powerful planning tool available. The Twin Cities Metropolitan Council has given teeth to its metropolitan land use plan, limiting suburban sprawl, encouraging central city and satellite town development, and protecting farmlands, through a combination of state property tax amendments and a specific time frame for sewer extensions reaching thirty years into the future. While steering future

development, such infrastrucutre control can also serve to define in advance the maximum capacity of all service elements to prevent future congestion, overbuilding, and poor linkage to streets, transit, and other buildings.

VI. CONCLUSION

In the preceding sections I have outlined what appears to me to be a scenario of the development of American urban centers in the next twenty-five to forty years as influenced by the rising costs of natural energy and its uncertain availability. Here is a brief recapitulation of what was presented, followed by some closing remarks.

Through an inspection of numerous respectable sources, a concensus of predictions was gleaned regarding future energy availability, price, and source together with assessments of current and future U.S. energy needs. It clearly appears that the U.S. shall have to make it through the remainder of this century on a restricted energy diet.

An interesting report from the Real Estate Research Corporation highlighted a brief analysis of how variations in residential land use and building type can markedly influence energy consumption in that sector. Sadly enough, the majority of land use and building design in American cities is highly wasteful of enrgy, not a surprising result given the abundance of power we have enjoyed in recent decades.

The examination of energy consumption as influenced by land use and transportation very neatly set the stage for the introduction of the heart of the paper. In a bold but not unfounded prediction, I stated that many of our metropolitan areas will witness the evolution of a new urban form, one in which greater diversity of metropolitan services and functions will be offered in every section of the urban area so that circulatin demands are eased. Suburban sprawl will be sharply curtailed, the CBD revitalized, older residential sections will receive new attention, and commercial/office/recreational centers will mature to rival the CBD. Residential densities will be increased

in outer areas of the central city and the suburbs, especially around commercial/employment activity centers and transit station areas. An overall effort will (or should) be made to shorten the distances between the basic daily activities: home, work, school, shopping, and recreation.

An improved family of transportation services will be part and parcel of this new movement, making it possible and encouraging its success. Use of the car will diminish as other modes enjoy rising patronage. The next twenty years will witness the completion of new and/or improved bus and rail transit systems. A system of small (two to six passengers) rail-guided cars, some of which may ultimately be operable on the street as well, may evolve to fill the need for fast metro transit in off-rush hours. With increased walking and bicycling, improved auto design, and increased use of mass and personal transit systems, transportation energy can be slashed while exerting a profound positive influence on urban form.

The CBD should regain much of its lost importance as new residential areas are built on its periphery or its heights, some lost retail business returns, CBD design becomes more responsive to the needs and desires of the pedestrian, and architecture takes greater advantage of the swift movement of people offered by a transit system and sophisticated interior pedestrian circulation concepts.

The greatest change in residential neighborhoods will be the introduction of many new apartments and townhouses, many with engaging designs accompanied by a number of amenities desired by middle class residents.

All of these ideas will be worth nought if certain improvements are not made in the governmental, legal, and financial web of implemenation. A great deal of the stimulus to affect change will have to arise from concerned individuals and from

enlightened private businesses. Land, which has so long dominated the urban development mechanism, will have to be replaced by the more sophisticated and realistic concept of enclosable space. The city must be envisioned increasingly in three dimensions. And, finally, I believe that planning and planners will be given greater importance and assume increased influence in the process of guiding the growth of our cities.

What are the prospects for such changes actually occurring? To be realistic, I would have to admit that it is highly unlikely that all the changes will take place to the extent I have described them in existing cities, although most every city ought to experience some of the evolution as I have described it. Currently existing facilities are simply too slowly changed. New towns will present the greatest opportunity for the development of the compact design I advocate.

Above all, I hope that this, the second half of the Twentieth Century, will be looked back upon as a critical period of maturation of the American metropolis. I hope that our efforts to conserve energy result not simply in an energy efficient city but in a city which is also a delight to live in, which offers opportunities, convenience, health, and personal happiness. I believe that these energy shortages will turn out to be beneficial for the city in the long run by initiating a movement which will result in a wiser, more productive use of land, a revitalization of the central core, and a renaissance of the residential neighborhood. To accomplish such goals we must possess two qualities above all: one, conviction that changes need to be made and, two, confidence that beneficial change is indeed possible.

FOOTNOTES

1.) "Energy: End of an Era?," Commonweal, 99:527-530, March 1,1974.

2.) "Clean Power from the Sun," Nation, 217:429-432, October 29, 1973.

3.) From 1960 to 1970 annual sales of window air conditioners jumped from 2,75 million to almost 5 million.

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5.) "Energy Supply," Newsweek, 82: 71-72, July 9, 1973.

6.) "Energy Sources of Tomorrow," Nation's Business, 62: 21-22, February 1974.

7.) Freeman, David S., Energy: The New Era, (New York, 1974), p. 65.

8.) Ibid., p. 91.

9.) Ibid., p. 101.

10.) "Is There an Energy Crisis?," The Public Interest, 35-42, Spring 1973.

11.) Robert R. Grinsted, "Bottlenecks," Environemnt, 14:3, April 1972.

12.) Freeman, op.cit., p. 38.

13.) Ford Foundation, A Time to Choose: America's Energy Future, p. 79, 1974.

14.) Freeman, op. cit., p. 107.

15.)Freeman, op. cit.,p. 88-89.

16.) Grinsted, op. cit., p. 5.

17.) Freeman, op. cit., p.5.

18.) "Energy Joyride is Over," Bulletin of Atomic Scientists, 29:39, October 1973.

19.) Freeman, op. cit.,p.91-95.

20.) Freeman, op.cit., p.98.

21.) "Fusion Reactors as Future Energy Savers," Science, 186:397-407, November 1974.

22.) Farno L. Green, "Energy Potential from Agricultural Field Residues," Michigan Free Press, September 1, 1975, p. 2.

24.) Freeman, op. cit., p. 241.

25.) Real Estate Research Corporation, The Cost of Sprawl, (Washington, 1974).

26.) Ronald L. Howath, "Machine Space," Geographical Review, p. 168.

27.) A service network is the physical placement in a city of resources,

whether they be grocery stores, banks, hospitals, schools, churches, or indoor tennis courts.

27a.) Adapted from Wolf, Peter, The Future of the City, (New York, 1974), p. 151.

28.) Ibid. p. 57.

29.) Ibid,, p. 61.

30.) Webber, Melvin, "Order in Diversity:Community Without Propinquity," Cities and Space, (ed. L. Wingo, Jr.), Baltimore: Johns Hopkins Press, 1963.

31.) Anthony downs, "The Future is Demographic Change," Robert W. Burchell (ed.) (New Brunswick, N.J., 1975), pp. 305-323.

32.) Dantzig, George B., Compact City (New York, 1973).

33.) Rudofsky, Bernard, Streets for People, (New York, 1969), p. 114.

34.) Burco, Robert S. and David A. Curry, Future Urban Transportation Systems: Impact on Urban Life and Form, (Washington, 1968), p. 105.

35.) The majority of the comments regarding innovative transit possibilities, in particular the PAS and NET systems, were gleaned from Burco, 1968.

36.) Stone, Tabor R., Beyond the Automobile (Englewood Cliffs, 1971), p. 87.

37.) It should be noted that many (if not all) of the planning and design concepts which are advocated here for the CBD can also be applied at, perhpas, a reduced scale to any other high density development in the city, particularly in the secondary activity centers advocated for the multi-nucleated city of the future.

38.) Okamota, Rai, "Urban Design Determinants in Seattle and New York," Journal of the Franklin Institute, v. 28, no. 5, p. 401, November 1968.

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