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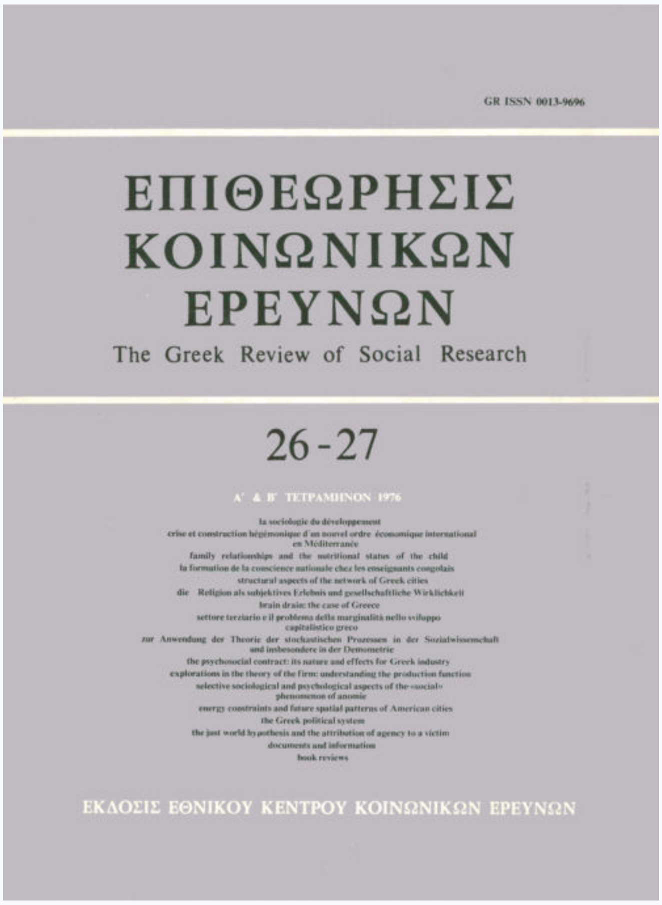

Energy constraints and future spatial patterns of American cities

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energy constraints and future spatial patterns of American cities

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ABSTRACT

During the modern industrial era there have developed several significant changes in urban land use and transportation patterns. These changes are largely tied to the use of energy in combination with new technology.

This paper seeks to examine how urban land use and transportation patterns have responded to continually increasing per capita energy consumption levels.

New energy consumption levels associated with expected energy shortages are also examined. It is theorized that the spatially-expanding urban complexes of today will begin to solidify and become more densely utilized with respect to both land use and population settlement. This new urban spatial pattern will highlight the need for sound and comprehensive regional land-use planning.

A model of planning organization in such a context is proposed which seeks to achieve regional development objectives within the context of declining per capita energy consumption.

The modern industrial era has given rise to a remarkable series of spatial changes with respect to patterns of urbanization. These changes have been invariably related to the technology of transportation. At the beginning of the industrial era, when the railway had still not yet been invented, foot travel, the horse and horse-drawn carriages in the case of temperate climates, and bullock carts in the case of tropical climates, were the main means of transport. The limited means of transport simply did not encourage the city to grow outwards, thus restricting its spatial size. However, with the introduction of railways and, eventually, urban-based trolley car systems, by the middle of the 19th century, star-like ribbons of settlement began to develop around cities. These new technological innovations gave the city *Lebensraum* (S.B. Warner, 1969). The city was now a dynamic, moving, ever-changing organism which fed voraciously upon the surrounding land and its resources.

The techniques of steel frame construction and the invention of the elevator accentuated the stellar development of the city. Expansion of center-city activities assumed both a horizontal and a vertical dimension, while residential displacement outward progressed according to an economic filtering mechanism favoring the geographic decentralization of the wealthy and the centralization of the poor. Still, the railways and trolley cars required a large volume of passenger traffic in order to run economically. Therefore, these technologies did not cause much relaxation in density patterns, although the size and areal extent of the cities expanded considerably.

automobile use and resultant spatial pattern

Automobile technology, introduced in the early part of the 20th century, became initially effective in changing the spatial pattern of the city through use of bus transportation. Buses have more spatial flexibility than do railways and trolley cars. Their addition to the urban vehicular base resulted in the filling in of the empty areas between the railway tracks—i.e., the spaces between the arms of the star—which previously had been inaccessible from the city center. Buses require a comparatively lower density of population to economically support their operation. Therefore, the population build-up that followed the introduction of bus technology was, generally speaking, more spacious with regard to housing and dwelling units—i.e., town houses and single-family detached dwellings.

That unsurpassed convenience, the automobile, coupled with the ability of individuals to purchase and maintain it as a result of personal affluence, has resulted in the ceaseless sprawl of ever-expanding suburbs. The central business district, which was so very accessible in terms of Burgess' conception of concentric zones (Park, Burgess and McKenzie, 1925), became increasingly less accessible because of intense traffic congestion and parking difficulties at the center, as well as spatial displacement of the general population and land-use pattern away from the center. The resultant inconvenience eventually led to the decentralization of core area activities. Suburban shopping centers, industrial parks, outside recreation centers and coliseums, suburban truck terminals, as well as other businesses followed people outward. These clustered together into a new set of decentralized activity modes. The Harris-Ullman multiple-nucleus theory seems to explain this new multi-nodal spatial setting more adequately than the previous mono-nodal theories (Harris and Ullman, 1951).

However, the automobile age, with its large-scale spatial expansion and decentralization of residential and non-residential land uses, is the direct result of the internal combustion engine which runs on gasoline. Nature has provided the United States with only a limited supply of petroleum. It is estimated that, at the current rate of use, all known petroleum resources will have been exhausted within the next two decades (Meadows, et al., 1972). The first pinch of a gasoline shortage was felt in 1973. It was then realized that the long deferred issue of energy availability had to be addressed. A fear was then generated in the minds of most people about the ever-increasing cost of gasoline as well as its eventual non-availability.

The 25 years that followed the Second World War in the United States marked the maturing of a pattern of decision-making concerning the location of new homes. The crucial element was time—i.e., travel time. Since 1973 an additional factor has been introduced, i.e., the increased cost of commuting. Therefore, the decisions regarding the location of new housing that are now being made are taking into consideration the distance factor to and from the place of work. In other words, the era of ever-expanding city limits appears to be ending. People will have a greater tendency in the future to locate their housing as near to their place of work as possible.

energy constraint and shaping of future urban form

Our storehouse of conventional fuels is rapidly dwindling and a continued dependence upon them would result in exhaustion of these fuel supplies within a relatively short period. Alternative sources are either environmentally risky, such as nuclear energy (Commoner, 1973), or technologically unavailable in economic quantities for use, such as solar energy (Odum, 1973). These constraints make necessary the development of a radical energy conservation policy that may encompass most, if not all, of the following elements: (1) lower levels of individual energy consumption; (2) lower overall growth of the economy; (3) lower and eventually zero population growth; (4) the restructuring of existing land use and transportation patterns to minimize resource and, especially, energy use.

The past city form, as indicated in Diagram I and Diagram II, which has been so common on the American scene will probably be less valid in terms of explaining urban land-use change in the future. Instead, a form will emerge, as indicated in Diagram IV, in which the central business district will undergo extensive rejuvenation. The zone around it, consisting of the inner city and the neighborhoods of black and ethnic populations in many instances, will become the locus for increased land-use and population settlement development. Zone 3, consisting of existing suburbia, where considerable decentralized non-residential land uses such as shopping centers and industries have also been located, will witness not only increasing density but will become the outer boundaries of the city of the future. Thus the city of tomorrow has the prospect of increasing its population density which is a precondition for the economic maintenance of a masstransport system. Though mass transport may be brought in on a subsidy basis by the government in order to reduce the consumption of gasoline, still the metropolitan area of the future will possess all of the necessary preconditions for the economic maintenance of a mass transportation system.

Will such a mass transport-based city then return to the mono-centered CBD activity characteristic of the Burgess (Park, Burgess and McKenzie, 1925) and Hoyt (Hoyt, 1939) conception? The authors believe that the spatial inertia resulting from the enormus size of the city will require a multiple-nuclear spatial pattern to complement the operation of a nodal network of interconnected activities. It is, however, also highly improbable that any further development of commercial centers will be feasible. Rather, existing shopping centers and industrial districts will gradually become more intensively utilized.

Such a future city will also need substantial and continuous sources of energy. Use of energy, however, will be on a cooperative rather than an individual basis, thereby permitting economies of scale which will allow a stabilization in overall usage volume and, hopefully, an absolute decrease in energy utilization. The form that energy utilization patterns will take with regard to types of energy utilized will depend upon: (1) energy needs required for the new spatial environment, (2) the requirements imposed by realistic energy conservation policies, and (3) the need to create and maintain a pollution-free environment around us.

a strategy for planning the future cities

Given this interconnected matrix of present and potential problems associated with the demonstrated need to reorganize the spatial framework of urban areas, there is a concomitant need for a rational decision-making process that seeks to relate the benefits and liabilities of alternative actions taken to achieve the equilibrium state; a state in which a homeostasis condition exists relative to use of existing energy resources and the creation of new energy resources. The comprehensive planning process provides us with such a mechanism. We can think of this process as taking two forms. The simpler of the two is the sequential approach to planning decision-making in which a continuous and uninterrupted process, beginning with the delineation of needs and desires, is made subject to constraints imposed by economic and social realities. Innovative or creative planning can be introduced at this point to facilitate the harmonious meshing of perceived needs and desires with actual constraints imposed by the real world in the form of scarce resources or conflicting value systems. The outcome of this process as modified by creative planning is a spatial configuration that seeks to optimize living conditions within the subject area for the maximum number of people. Alternatively the dynamic model utilizes a feed-back mechanism at each important step in the decision-making process such that information or assessments obtained in subsequent phases of the process can be utilized to modify or reformulate objectives associated with earlier steps. These two processes are graphically depicted in Diagrams V and VI.

As we begin to move into an era in which centripetal forces shall begin to reshape our cities and urban areas as opposed to the centrifugal forces of the preceding era, the need for coordinated planning becomes imperative. The tendency, associated with increased land use and population density, toward confrontation and conflict must be minimized if we are to maintain our existing social system. Such a situation calls for the use of a rational decision-making process incorporating urban and regional land-use and transportation planning.

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DIAGRAM I

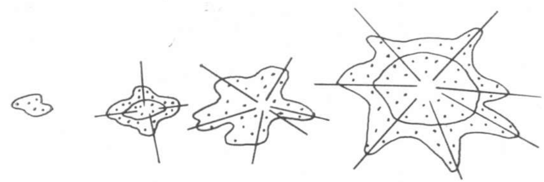
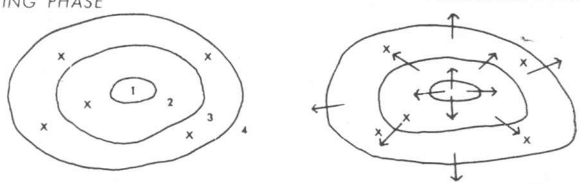


DIAGRAM II

DIAGRAM III



1- Central Business District: Redevelopment/Renewal

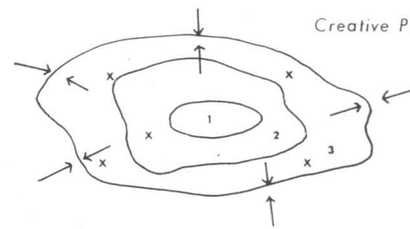
2- Central City: Conservation/Static or Declining Growth

3- Suburbia: Fast Growth

4- Commuters Zone

X- Subsidiary Centers: Shopping, Industry, University, etc.

DIAGRAM IV



1- CBD: Rejuvinated

2- Central City: Increasing Density

3- Suburbia: The Limit of the Future City

X- Subsidiary Centers: Shopping, Industry, University, etc.

Two Suggested Decisional Models for Urban Planning

DIAGRAM V
SEQUENTIAL APPROACH

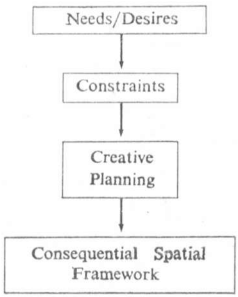


DIAGRAM VI
DYNAMIC APPROACH