HIGHWAY RESEARCH RECORD

Number 2

Community Values as Affected by Transportation

7 Reports

Presented at the
42nd ANNUAL MEETING
January 7-11, 1963

HIGHWAY RESEARCH BOARD
of the
Division of Engineering and Industrial Research
National Academy of Sciences—
National Research Council
Washington, D. C.
1963

Special Committee on Urban Transportation Research

Pyke Johnson, Chairman
Washington, D. C.

Lewis J. Ross, Secretary
Engineer of Economics, Finance and Administration
Highway Research Board

Robert J. Anderson, Assistant Surgeon General, Deputy Chief, Bureau of State Services, Public Health Service, Washington, D. C.
Donald J. Bogue, Associate Director, Population Research and Training Center, University of Chicago, Chicago, Illinois
J. Douglas Carroll, Jr., Deputy Director, Tri-State Transportation Committee, New York, N.Y.
Harmer E. Davis, Director, Institute of Transportation and Traffic Engineering, University of California, Richmond
Henry Fagin, Professor of Planning, Department of Urban and Regional Planning, University of Wisconsin, Madison
Luther H. Gulick, President, Institute of Public Administration, New York, N. Y.
Edward H. Holmes, Director of Planning, U. S. Bureau of Public Roads, Washington, D. C.
J. B. McMorran, Superintendent of Public Works, New York State Department of Public Works, Albany
Burton W. Marsh, Director, Traffic Engineering and Safety Department, American Automobile Association, Washington, D. C.
D. Grant Mickle, Deputy Federal Highway Administrator, U. S. Bureau of Public Roads, Washington, D. C.
Robert B. Mitchell, Chairman, Department of Land and City Planning, University of Pennsylvania, Philadelphia
Gordon M. Murray, U. S. Bureau of the Budget, Washington, D. C.
Wilfred Owen, Senior Staff Member, The Brookings Institution, Washington, D. C.
Clifford F. Rassweiler, Vice President for Research and Development, Johns-Manville, New York, N. Y.
Morten J. Schussheim, Assistant Administrator for Program Policy, Housing and Home Finance Agency, Washington, D. C.
Donald C. Wagner, Managing Director, Philadelphia, Pennsylvania
Coleman Woodbury, Director of Urban Research, University of Wisconsin, Madison

LIAISON MEMBERS

Earnest Boyce, Chairman, Department of Civil Engineering, The University of Michigan, Ann Arbor
Fred W. Hurd, Director, Bureau of Highway Traffic, Yale University, New Haven, Connecticut
John M. Roberts, Professor, Department of Sociology and Anthropology, Cornell University, Ithaca, New York

Contents

Opening Remarks

PYKE JOHNSON, Chairman, Committee on Urban Transportation Research

• TODAY'S SESSIONS are the third to be held by the Special Committee on Urban Transportation Research of the Highway Research Board. Their purpose is to focus public attention on the various problems of urban life as affected by transportation and to secure financial support for research by public officials, universities, foundations, and industry.

The title of this symposium is "Community Values as Affected by Transportation." Chairman for the first session is Douglas Carroll, who is about to become deputy director of the Tri State Metropolitan Area Study and who perhaps more than any other man has sought to find out what it is that the user wants out of transportation.

Harmer Davis, formerly chairman of the Highway Research Board, serves as commentator. In his capacity as director of the Institute of Transportation and Traffic Engineering, Prof. Davis has been one of a team that has worked together to develop highway transportation in California.

Introductory Remarks to the First Session

J. DOUGLAS CARROLL, JR., Director, Chicago Area Transportation Study

• BECAUSE urban transportation is a human activity, it is going to be continually evaluated and valued by each user. Now, there is nothing inherently good or bad about a road, a streetcar, an airplane, or an automobile—these are, in fact, artifacts of our society. But when such artifacts are introduced into urban settings and used and observed by urban dwellers, there are effects on people and these effects are judged to be "good" or "bad."

How such effects are assessed and how they are classified as to goodness or badness depends on the values set by the people involved. Knowledge about such values should help to produce better designs—more satisfactory route locations or more acceptable restraints on usage. Any of these attempts at betterment, however, must in turn be governed by the summation of the evaluations of a large number of people. Changes will be successful as they are responsive to this summed weight.

However, there is a saying among engineers to the effect that if you cannot measure or count it, ignore it. What values of what people are being considered? And who assesses these values? What is one unit of value? Who can pin down and count community values? How can these undeniable values be weighed out so that a public official can be given the "before" and "after" value total? How, in short, can one action be objectively appraised as better than others?

An example may illustrate these difficulties. How does one assess the frequent complaints about travel time to and from an airport? How many meetings, editorials, and conversations have been heard on this subject? A quick mental assessment indicates that in city after city the first or second freeway built was directed to the airport. Yet a very small and select segment of the urban population travels by air. In Chicago, for example, on an average weekday, of 10,000,000 journeys made, only $^{3}/_{10}$ percent were to the airport and less than one-half of these were made by persons who were going to fly.

It is possible that the persons who do fly have more important jobs. Moreover, it seems reasonable that time is more important to an individual when he is going to or from an airport than at other times. But it is also possible that the vocal power or access to media or to the ears of public officials gives this segment of the population's values a disproportionate weight in guiding public policy. So, how can the "correct" appraisal of values be made?

The measurement of values is difficult, but the importance of this task cannot be denied. Every choice made carries some balancing of values. So, clearly, if we are to light the way towards better cities, healthier neighborhoods, and more satisfactory urban travel, we must come to grips with this matter of sorting, weighing, and measuring these human and community values.

This is the problem area being probed by the participants in this symposium. That there are two economists present probably reflects the traditional concern of their discipline with these problems. But we will also be treated to different ways of looking at values through the eyes of the social psychologist and the urban designer.

The Demand for Transportation Services In a Growing Economy

CHARLES J. ZWICK, Head, Logistics Department, The RAND Corporation, Santa Monica, California

• THE IMPORTANT ROLE of transportation in the growth of an economy has been frequently documented. During the first stage of this country's development, water transportation, for example, was clearly a major force. There was the early clustering of economic activity around seaports; later, canals were dug to link sources of vital raw materials with industrial areas and the seaports. And, of course, the building of the transcontinental railroads ushered in a major expansion for the U. S. economy during the nineteenth century. More recently, the development of a highway system, pipelines, and air transport has provided easier access to all parts of the United States. Again, significant economic development can be linked to this change in transportation technology. In short, transportation has played a significant role in stimulating the economic development of the United States and shaping the particular form it has taken.

The major theme of this paper, however, is that in an advanced economy like that of the United States, this causal relationship has changed, and this change in the interaction between economic development and transportation has great significance for the transportation industries. The nature of this change and some of its implications will be briefly outlined. More specifically, it will be argued that a level of development has been reached in the United States where causation is reversed. That is, there is now a relatively high level of per capita income and a relatively ubiquitous supply of transportation in all areas of the United States; and as a result, most future economic growth can be expected to be rooted in forces exogenous to the transportation industry.

As future transportation requirements will be intimately linked to this growth, the future development of the economy must be anticipated in planning future transportation systems. Chief among the forces that will shape future transportation requirements are a changing industrial mix, an increased discretionary element in people's budgets, and the complementary nature of transportation.

With regard to the first of these—the changing product-mix of the economy—several points should be made. First, as the economy grows, the labor and capital component of output increases relative to the raw-material input; and becasue labor and capital are mobile, industry is finding it less and less necessary to be tied to particular geographic areas. This trend is accelerated because the present transportation systems provide good access to most areas. Consequently, it can be expected that industry will become more mobile, and that it will locate closer to its markets rather than to its sources of raw materials. This change will be a major factor that must be taken into account in planning for new transportation facilities.

A second aspect of the changing product-mix is that as incomes have gone up, the demand for services has increased more than that for goods. That is, one now buys relatively more packaging along with foods, more personal services, more recreational activities, etc. These service activities tend to be consumer-oriented and therefore highly related to residential patterns.

A short but revealing way to summarize these developments is to point out that both these trends in the product-mix of the economy lead to the expectation that employment patterns will be much more highly dispersed than they have been in the past. The impact of this on journey-to-work patterns is clear.

A major feature of an advanced economy is that its population is relatively better

---

Paper sponsored by Special Committee on Urban Transportation Research.

off with respect to per capita income; in fact, per capita income is widely used as an index of economic development. When people's per capita income rises, the discretionary element in their budgets becomes more important. Stating this another way, people in an underdeveloped country exhaust most of their income in meeting the basic requirements of food, shelter, and clothing; in the poorest countries, they may not even meet these basic needs. As people become wealthier, they can start demanding more quality in these items, and thus open up room for individual preferences to express themselves. That is, some would rather spend more income on housing services, whereas others prefer to spend it on clothing or a particular form of transportation, etc.; this flexibility may be called the discretionary element within the budget.

Because of this trend, it is important to know more about consumer preferences than was known in the past in order to make decisions with regard to transportation services; for example, vehicle design or highway planning. It is clear that rising per capita income is making quality of service more and more important. Today there is less need to seek the minimum cost method of moving people; rather, given people's wants and desires, what the most desirable transportation system is must be anticipated.

From the evidence to date it may be concluded that most Americans want higher quality in their transportation systems, in that they are willing to pay for such advantages as privacy, flexibility, and time-saving. In the 1930's consumers allocated about 9 percent of their total expenditures to transportation; in the late 1950's (with higher per capita income) they allocated 12 percent (Table 1). However, these preferences (simple enough when seen as a list) are full of implications; these preferences must be understood much better than they are now if the desirable characteristics of future transportation systems are to be forecast correctly. How much are people willing to spend on additional privacy or time-saving? Or, conversely, how much cheaper would a system have to be to induce people to give up some privacy or flexibility?

A third major force is that of the complementary nature of transportation. In a relatively advanced economy like that of the United States, people are buying goods that by their very nature increase the demand for transportation services. Chief among these is individual home ownership—certainly one of the strongest desires and goals of the society. In 1900, 35 percent of the U. S. population owned homes, while

TABLE 1

PERCENTAGE DISTRIBUTION OF PERSONAL CONSUMPTION EXPENDITURES[a]

Year	Distribution of Personal Consumption Expenditures (%)							
	Total Consumption Expenditure	Housing & Household Op.			Clothing and Shoes	Food and Alcohol	Trans. and Travel[b]	Other Goods and Services
		Total	Housing	Housing Operation				
1930-34	100.0	30.8	16.4	14.4	10.8	24.9	8.5	24.9
1935-39	100.0	27.7	13.1	14.6	10.5	29.0	9.4	23.4
1940-44	100.0	26.0	11.7	14.3	12.2	31.7	7.1	23.0
1945-49	100.0	24.7	9.9	14.8	11.7	32.2	9.2	22.2
1950-54	100.0	26.9	11.5	15.4	9.7	28.5	12.2	22.7
1955-59	100.0	27.7	12.5	15.2	9.0	26.0	12.6	24.7

[a] "Housing Statistics, Annual Data, March 1960." Housing and Home Finance Agency, Washington, D. C., Table A-35, p. 38.

[b] Includes automobiles and parts, gasoline, and oil, as well as other modes of transportation.

65 percent rented. By 1957, 60 percent of the population owned homes. The 1957 data by income groups show that over 83 percent of the families with incomes above $10,000 owned homes in 1957. In short, home ownership has increased rapidly and will probably continue to do so as the society becomes wealthier. Among other things, this desire leads to a low-density residential pattern.

Low-density residential patterns mean, in turn, that the demand for transportation services goes up and the mode of travel will probably change. Investigation of the trip-making behavior of Detroit workers indicates that people who live in one-family dwellings are much more likely to drive to work than those who live in multiple dwelling units. One of the challenges today is how to provide an efficient public transportation system in the face of low residential densities and more dispersed employment.

Also, the demand for recreational activities is growing rapidly. Shorter work weeks and higher incomes allow families to spend significantly more on recreational activities, which again may require new transportation facilities. Much more needs to be known about the distribution of these activities. For example, if such cultural activities as theaters, concert halls, and museums are concentrated, as one would expect them to be, one sort of transportation demand is generated. If they are dispersed, like such outdoor recreations as camping and boating, there is another type of transportation problem.

Certainly the time pattern of transportation demands will be altered as recreational activities increase, and the peaks in transportation demands could change. It has been reported that there are greater traffic peaks on the George Washington Bridge on week ends than during the early morning and evening journey-to-work hours which are usually thought of as creating the peak demand on the transportation system.

What is argued, therefore, is that when an economy reaches an income level like that of the United States, and develops as extensive a transportation system, the nature of causation between economic development and transportation changes drastically: whereas advances in transportation technology once drove and fostered economic development, in time the growth of the economy becomes largely independent of changes in its transportation system.

If this basic hypothesis is accepted, certain lines of study take on urgency within the transportation industries. First of all, it is important for the transportation industries to devote a significant effort to understanding how the economy will change over time. With regard to the changing industrial mix, there is clear evidence that industry will be less raw-material oriented, and a greater proportion of the output of the economy will be in service activities. The locational patterns and habits of these industries should therefore be understood because they will increasingly affect the employment distribution of the economy, and thus journey-to-work patterns.

Secondly, much more needs to be known about consumer preferences than was necessary in the past, in view of rising per capita incomes and the increasing discretionary element in household expenditure patterns. As mentioned before, consumers are clearly asking for higher quality in their transportation service; but how to define "higher quality" is an important piece of unfinished business. Safety, speed, flexibility, and privacy, at least, are known to be aspects of quality; what needs to be done now is to measure their relative worth to consumers, if consumer preferences are going to be considered in designing new transportation systems. And finally, increasing home ownership and rapidly expanding recreational activities are also important because of their complementary nature to transportation. By studying their growth, much will be learned about future transportation requirements.

By way of summary, in assessing the relative merits of alternative transportation investments, it is important to consider fundamentally the trends discussed. If the prognosis is correct, the success of future transportation systems will depend to a greater degree than in the past on consumer preferences—notoriously capricious, but not without some regularity. A major challenge facing everyone concerned with planning new transportation systems, particularly urban transportation systems, is identifying these preferences and forecasting their future effects.

Interactions Between Transportation and Urban Economic Growth

ROBERT C. COLWELL, Economic Advisor, Urban Renewal Administration, Housing and Home Finance Agency

• SINCE the dawn of recorded events, commerce has been a dominant force in shaping the spread of culture, the development of continents and the growth of urban settlements. Anthropologists have recognized the significance of trade and transport in the diffusion of cultural concepts and the infusion of populations, among both primitive and prehistoric peoples (1).

In the history of the economic development of the United States, the record is clearer, and the causal relations more direct. Harold U. Faulkner (2) reports:

> Along with the increase and westward movement of population went its concentration in cities. The causes for this were many, most of them attributable to the Industrial Revolution. . . . The development of means of communications by canals and later by railroads allowed a greater distribution of agricultural produce and an expanded foreign commerce, leading to the growth of cities at collecting and transfer points. The market for agricultural products speeded up the western movement, which in turn added to the population of important points on routes of travel.

Charles and Mary Beard (3) also describe in some detail how the frontiers of transportation released dynamic forces that changed the social currents of the U. S., first with the introduction of the steamboat, then with the grand trunk canals, and shortly thereafter, with the railroads: "All over the Middle West, crossroads hamlets grew into trading towns, villages spread out into cities, cities became railway and industrial centers."

Thus the record clearly shows that urban development in the United States was largely spawned by commerce and the utilization of natural resources. The selection of the original location of many settlements that grew into towns and then into cities was governed chiefly by the economic feasibility of access, which in turn generated traffic in the movement of both goods and people. The shape of urban growth within cities has been greatly influenced by terrain and transportation. Only in relatively recent times have zoning and other land use controls been factors in the shaping of city patterns.

A cursory examination of early maps of the United States will indicate that settlements sprang up where favorable transportation induced commerce. Along the seaboards, natural harbors led to the earliest of villages, which grew apace with immigration, trade, and manufacturing. Inland settlements often arose at the confluence of navigable rivers, along lakes and canals, at the crossing of prairie trails, or near the entrance to mountain passes. The juncture or intersection of two or more traffic routes was particularly likely to give rise to a trading center. Time has all but erased the record of these early transportation advantages as trails vanished or became highways, as canals were abandoned and river traffic was generally confined to barge shipment of bulk materials. But in the places where the economic feasibility of commerce dictated original settlements, cities now survive, supported by a complex pattern of productive activity, nurtured by trade and the exploitation of resources.

The economic feasibility of commerce at settlement locations is a reflection of the marginal cost of transportation. As transportation technology has evolved, the thresh-

Paper sponsored by Special Committee on Urban Transportation Research.

old of this economic feasibility has both broadened and declined. Because transportation costs, measured in real terms, are generally less than in the days of the stagecoach, canoe and flatboat, their relative importance to total costs has become less critical to many entrepreneurial decisions. Nevertheless, the role of transportation in shaping the pattern of urban growth is still very significant.

In his classic volume on "The Structure and Growth of Residential Neighborhoods in American Cities," Homer Hoyt (4) traces the form of city growth in many major cities, showing the successive impacts of new means of transit on both axial and central growth. Though this study is now close to 25 years old, the forces of growth that it identifies with electric surface lines at the turn of the century and the subsequent spread of highways are just as applicable to the urban scene today. Only the means of transportation has changed. Economic feasibility—now measured as often in terms of time as dollars—is a companion to physical access in governing the shape of urban growth.

As cities have grown into metropolitan areas, diversified frameworks of production, employment, and residence have evolved. Due in part to their geographical enormity, the modern metroplex has generated two major forms of traffic that are largely absent in smaller places.

One of these is the internal movement of large quantities of goods between destinations within the area. Such movements include both the successive stages of manufacturing processes, and the distribution of finished products through wholesale and retail trade channels toward end uses. The other is the daily trip of workers between homes and jobs and family travel within the community. In smaller places, manufacturing is more apt to be vertically integrated and simpler; distribution is also more direct from supplier to retailer. Shorter distances permit more people to walk to their destination, or confine their trips to a mile or two.

Both of these forms of traffic peculiar to metropolitan areas have sharp daytime peaks, placing burdens on traffic facilities and creating congestion in central business district corridors and in their approaches. This problem has been described in a recent article by Anthony Downs (5), "The Law of Peak-Hour Expressway Congestion," which applies the neoclassic tool of establishing an equilibrium when marginal costs are equated between the supplies of scarce commodities (i.e., time and travel routes). The economic consequences of travelers' choices, as they seek to minimize the real cost of transit—measured in elapsed time and in convenience as well as in dollars and cents—will have far-reaching effects on the pattern of future land use for residential and industrial purposes and on the rate of urban growth itself. One obvious consequence of congestion is spin-off from the central business district and an increase in crosstown traffic.

Recognition of congestion and the personal and public diseconomies that mount from its intensity has clarified both the need of more extensive public planning for highway locations and transportation routes, and also the desirability of controls over urban land uses. For example, in describing the projections of travel patterns in the Greater Hartford area, Charles F. Barnes (6) says,

> Starting with a regional projection of population and employment, a highway system is assumed to handle this generalized land use. . . . Historically, most transportation studies have worked within a framework which presumes that the metropolis will grow in accordance with an established city plan or zoning ordinance. Thus in the horizon year, the projected land uses conform explicitly to these predetermined plans. Although this may be a perfectly realistic approach, to the critical onlooker and the analyst alike, it does leave many questions unanswered.

Over periods of a decade or more, the degree of conformance of public and private actions to a land use plan and the degree of success of various measures taken to assure good conformance will probably be influenced by the care and the judgment that entered into the economic and demographic projections on which the plan is formulated.

And, of course, a transportation plan that is based on a misconceived land use plan or an unrealistic zoning concept will prove to be impractical or uneconomic. Hence, it is of particular importance that the employment and population forecasts be carefully and expertly derived.

A preferred starting point for an urban economic study is an examination of national and regional growth patterns that identify the expanding, static, and declining job-producing components of the economy likely to be present in the area during future years. Long-range local economic trends usually conform in general direction to the national patterns. Continued improvements in communication and transportation technology are likely to strengthen rather than weaken this conformance. For example, the introduction of new technology and automation in manufacturing industries during the last two decades has led to a decline in blue-collar employment and a counterpart rise in the hourly productivity of applied labor that has made substantial wage gains feasible. Further, the accelerated rate of investment in research, development, and engineering during recent years makes it more than likely that these employment and productivity trends will continue, but not with uniformity throughout industry. Electric trolleycar producers have recently joined the ranks of the buggy-whip craftsmen.

Although the precise nature of the techno-economic impacts of innovation on a particular plant—or a subject city—cannot be forecast with precision as to timing and extent, the identification of nationwide trends will point toward the sectors that call for closer study to determine their likely impact on firms now present in the area. The longer the term of the forecast, the greater the prospects of local conformance to nationwide patterns.

Thus the total picture of national growth components is a base to which local forecasts can be anchored, and from which local departures can be projected with greater realism. There are few large communities today that are not trying to induce the establishment of research activities (particularly, electronic) in their area. Others, both large and small, are striving for industrial diversification to counteract the probable continued decline of employment in heavy industry. But success of any particular community in maintaining its share of national growth rates and in shifting its employment and production structure toward more rapid growth will depend largely on the resources it has at hand and in prospect.

With nationwide and regional growth perspectives as a framework, a careful identification of local resources is the next step in particularizing data for the urban area. The focus of this descriptive inventory will be on the comparative advantages of local resources in relation to those of other places with which it must continue to compete, both for the attraction of new firms and the retention of those now present.

The resources of an area can be grouped under four major headings. First is the composition of the labor force, including those in the population not currently working. Among the characteristics to be studied are occupations by industry and by wage rate, as well as age, education, race, and sex. Second is the fixed private investment in plant, equipment and commercial structures, plus the public investment in community facilities essential to production. The fixed capital investment in the area is one measure of current productive capacity, both its absolute potential and its economic limits.

The third group covers natural resources of the area, including mineral, agricultural and timber assets, qualities of the terrain, and soil, water and air, as well as climate and physical location as they bear on the economic life of the community. The fourth group may be labeled "amenities," blanketing in all of the more subjective factors that comprise goodwill, and coloring the reputation of a locality as a good place in which to work and live. The ability of local government is a major amenity, along with the quality of the schools, recreation facilities, adequacy of the housing supply, and the history of labor-management relations. The efficiency of local transportation facilities is also an important amenity in major metropolitan areas.

In compiling a study of economic growth opportunities under these four major categories, the depth of detail required will depend on the time-span of the forecast sought, size and complexity of the locality, competitiveness of the economy with other communities with similar opportunities, and also availability of data and the size of the survey budget.

The sort of study that would be forthcoming under these four categories would appear to be only descriptive of things as they are. But the opportunity to do much more is large. Appropriate time series permit an inspection of rates of change and provide the basis for projections to guide forecasts of the future. Cost and price data, productive capacity, natural resources and local amenities, when placed in conjunction with significant counterpart information from competitive areas and from other regions, bear directly on the basic question of the share and shift in national growth that will be experienced in the locality as a result of the locational decisions yet to be made by business concerns and workers.

The secret of successful analysis of a local economy involves two talents. First is asking the right questions while selecting study data, and keeping these questions foremost at all times. Second is applying judgment and familiarity in appraising the significance of the facts. Often the outlook for a small or medium-size city may be more difficult to judge than the prospective growth rate of a major metropolitan area, even though the latter is more complex and its data sources more extensive. The largest places are more likely to grow with the national economy if their productive activity is well diversified. And a larger share of total employment will represent service-type activities rather than production of goods. Where the initial inventory of productive activities shows such diversification, some details that may be omitted in metropolitan areas will require careful scrutiny in smaller and less diversified localities.

Many purposes may be served by the conclusions of an economic study that leads to a forecast of local growth probabilities, expressed in terms of employment, personal income, population, and output by industrial classification. Plans involving housing requirements, transportation and highway needs, schools, public facilities, and land uses in broad terms can all be derived in the aggregate from the dimensions of the growth prospects for the area. Public and private capital investment requirements, as well as tax revenues and the quantity of various municipal services, will also be shaped by the same economic growth prospects.

However there are some needs that will not be served by a study of the kind being discussed. For example, such a study will not tell very much about where land uses will be changed within the city. It will not tell where new highways will be needed, where schools and housing will be built nor new shopping centers located. These are matters that have to be planned from an examination of detailed land use records, coupled with an intimate knowledge of internal shifts of population and places of employment within the area. Broad macro-economic studies will answer the questions of "how much" and "what kind," but not "where." Yet within the work papers of the economic growth analysis, there should be a wealth of detail that can be reoriented in terms of land use opportunities to throw light on the "where" question for subregional or micro-economic studies.

Similar information is often assembled by business management in making locational decisions regarding the construction of a new plant, an office building, a shopping center, an apartment building or a housing project. By employing the same methods and the same data that entrepreneurs would apply in land use and marketability studies, it may be possible for public officials to anticipate private decisions that may be made at later dates. Competence in this technique may be as important to public bodies as are various planning and land use controls.

In urban life there are some characteristics whose rates of change are so gradual and which lend themselves so nicely to forecasting that they may have a high degree of reliability for periods of a decade or longer. For example, population fertility, structural deterioration, thrift, consumption habits, and educational attainment usually change gradually, and the secular patterns of these components can be measured with some reliability in a stable population. But where marked changes occur in the age, income, and ethnic composition of an urban population because of changes in employment opportunities, even these normally sluggish elements may shift sharply as a result of the changed mix or composition of the population. Many other volatile elements of urban areas respond even more rapidly to population mobility and render earlier forecasts inaccurate.

Annual surveys by the Bureau of the Census have shown that about 20 percent of the

U. S. population change their place of residence every year. In this shifting between 1959 and 1960, 13 percent of the population moved to a new residence in the same county, about 3 percent moved to another county in the same State, and another 3 percent moved to a different State (7). Of all the data series that must be employed in an economic or a land use study, probably the most crucial, yet the most esoteric, is gross population mobility. Because of the importance of migration statistics, more attention is being paid to the characteristics of movers and their motivation. But until such information is widely available from direct enumeration, estimates of growth in employment opportunities probably provide the best approximation.

Besides population migration, innovations in technology that result in new means of production and new habits of consumption inject major elements of uncertainty in economic forecasts. Scientific, engineering, and commercial "break-throughs" have been tremendous. Some have come as by-products of research for national defense and space exploration. Others result from greater national emphasis on science and mathematics, coupled with larger numbers of scholars in university and industrial laboratories. Still others follow from heightened competitive pressures to devise new products for the mass markets.

The tempo of technological progress is rising, probably at an accelerating pace. The analyst of long-range local and national economic trends who is seeking to forecast growth potentials must be humble in the handling of data, and recognize a wide range of probable variation to allow for unforeseen changes in technology.

On the positive side, there has been an opportunity to learn quite a bit about the forces that have shaped urban development during the past decade. The pattern of growth has been repeated in many cities, particularly in metropolitan areas. Concurrent with the zooming rate of marriages and family formation following the end of World War II, single-family home construction rapidly spilled over city limits into the suburbs. The lack of public transportation from these outlying locations dictated the use of private automobiles for worker transportation. Rapidly rising family incomes made the purchase of an automobile possible, partly because of more liberal financing arrangements for the purchase of both the home and the car. A large number of working wives added to the family income, and soon the two-car family became commonplace.

The combination of the suburbanization of most new families coupled with marked increases in private automobile traffic and rising incomes led to a series of corollary results. First, urban traffic congestion became accute and pressures grew for new roads and highways to escape the central city. Second, public transportation either stagnated under rising operating costs or suffered absolute declines in passenger-miles. Third, outlying shopping centers with adequate parking space sprang up close to suburban housing concentrations, reducing the volume of trade, relatively even if not absolutely, in downtown department stores. Fourth, the decline or dormancy of central business districts brought new pressures on city tax revenues and led to plans to compensate for the changed shopping habits of families. Fifth, the lower income families that could not arrange to move to outlying locations remained in the older and depreciated housing surrounding the central core, forcing higher densities of housing use than had existed in these structures earlier in the century. Sixth, the schools and public facilities in the suburbs experienced the same kind of use-congestion that arose on the highways.

These symptoms of metropolitan growth during the decade of the 1950's have been well documented, and fortunately are widely known. In the last few years, the pace of growth has been not quite as hectic, and construction of housing, highways, and community facilities has made some headway in catching up with earlier accumulated demands.

But the end is not in sight. On the contrary, prospective increases in family formation as soon as the generation of post-war children finish their education will start the cycle over again. Meanwhile there are a few years in which to compensate for some of the needs that are unmet, and to develop longer range plans to guide future urban growth into more orderly patterns.

Yet because of the many local variations and unforseeable events, long-term forecasts need to be reviewed and updated every few years, where it is feasible to revise plans and the course of action based on them. This does not help much when highways and buildings have to be constructed now to serve a need for decades ahead. But it does provide a way to take other compensatory actions that may help to validate the original decision.

Highway engineers and urban economists have many complementary problems and parallel decisions to make. The engineer can better gage traffic densities in future years by using the forecasts of jobs and production made by his economist colleagues. Estimates of the length of trips, the number of workers, and the quantity of goods to be moved are governed by limits derived from macro-economic studies of urban growth prospects. At the same time, the judgments of the engineer in the design and location of highways will have a profound influence on not only the urban shape but on the efficiency of urban life. Today as in the days of early settlement, the kind of transportation and its setting is a major force in the locational decisions of many families and entrepreneurs.

REFERENCES

1. Wissler, C., "Man and Culture." New York (1923), Ch. IX; Kroeber, A. L., "Anthropology." New York (1923), Ch. VIII.
2. Faulkner, H. U., "American Economic History." New York (1924).
3. Beard, C., and Beard, M., "The Rise of American Civilization." New York (1930), Part I, pp. 636-640.
4. Hoyt, H., "The Structure and Growth of Residential Areas in American Cities." Federal Housing Administration, Washington, D. C. (1939), Ch. II.
5. Downs, A., "The Law of Peak-Hour Expressway Congestion." Traffic Quart. (July 1962).
6. Barnes, C. F., Jr., "Projection of Travel Patterns in the Greater Hartford Area." Traffic Quart., pp. 143-145 (Jan. 1962).
7. "Current Population Reports." Bureau of the Census, Series P-20, No. 113 (Jan. 22, 1962).

Urban Freeways and Social Structure—Some Problems and Proposals

MARVIN G. CLINE, Research Associate, Washington Center for Metropolitan Studies, and Assistant Professor of Psychology, University of Maryland

•THIS PAPER treats a newly identified force that those who build highways and other large-scale physical developments in congested urban areas have encountered. That force is society. Although a powerful force, its strength is transmitted through the political system in a more emotional way than land values or economic activity which are more commonly recognized. The force of society is expressed in anxieties and fears, frustration and loneliness, but also in loyalty and love. The intrinsically public decisions of highway building have already encountered these powerful forces in public hearings, in elections and referendums, in the press, and in legislative deliberations. They have effectively blocked some specific highway developments. Because the social sciences offer a way to understand these forces and to accommodate necessary public works to them, a beginning should now be made at a long, difficult, but inescapable study of social structure as it is influenced by large-scale physical changes, particularly urban expressways.

In the social world, as in the physical world, for each action there is a reaction. To the extent that reactions can be adequately anticipated, actions can be adequately planned. No better example of this proposition can be found than the planning and construction of highways. Consider the reactions or consequences of highway construction, and the precision with which they can be anticipated. The cost of moving great volumes of traffic from one point to another can be precisely established and related to the anticipated benefits accruing to the users of the highway. Further, the changes in the value of the regions connected by the highway can be estimated in advance, as can the changes in the value of the land through which the highway passes. All of these changes in value can be compared to the cost of moving traffic (land acquisition, construction, maintenance, etc.) so that a net worth of the highway can be stated in advance of its construction. Certain other effects (or impacts) can also be estimated in advance, such as the change in accessibility of some functions and institutions (schools, churches, medical facilities, recreation areas, shopping centers, etc.) which can be used to predict changes in location of residential populations. All of these consequences have been measured after the fact (2, 7, 26, 31, 33, 38, 39) and they undoubtedly have been incorporated in the decision-making processes for most of the larger highways recently constructed.

This is an admirable accomplishment. One cannot help but be impressed by the skill with which these measures have been taken, and the accuracy of the predictions made. It is to be hoped that all aspects of planning reach this level of precision before too long.

However, one gets an impression that some consequences of considerable importance may not be included in the balance sheet, and that this formula for decision-making may be lacking some critical variables. For example, a gross variable (which may be so gross that it cannot be entered into the formula) has to do with the kind of urban structure one wishes to develop. The construction of a freeway system connecting the suburban fringes with the central city may be contributing to the destruction of the central city by enhancing the dispersion of precisely those functions which are critical to the central city. That is, it is the concentration of retail, industrial, recreational, cultural, and educational functions in the central city that makes it the vital core of the whole city. The freeway system, by enhancing the dispersion of populations, may at the same time enhance the flight of many of these activities to the new outlying

---

Paper sponsored by Special Committee on Urban Transportation Research.

population centers. This can, of course, place added burdens on the freeway system in order to make the new locations of these activities more accessible. These consequences may or may not be desirable, but they are, at least at present, inadvertent. To that extent, freedom to plan in the future is being restricted by a lack of planning in the present. At the same time, if freeway planning is not integrated with more comprehensive urban planning, the freeways may become self-defeating (the more one builds, the more dispersion, the more one has to build). Hence, they become less economic (32).

However important this variable is, it is not the only one which appears not to be included in the current methods of evaluating highway plans. Another variable involved here is becoming an increasing source of political conflict and, for the transportation planner, embarrassment. This variable has to do with the reactions to the freeway on the part of the resident through whose neighborhood the freeway is to go. It is not necessary to document the rapidly growing number of instances in which irate citizens, civic organizations, and political groups are complaining about routes, interchanges, and access streets. Every transportation official must be painfully aware of the complaints arising from this ill-considered population. To date, the primary complaint has to do with the problem of relocation, but this is by no means the only significant issue.

Those who will not be removed from the path of the freeway, who will have to live with it, may shortly discover that they too have a considerable stake in the planning of urban transportation systems. These people will be challenging a critical and implicit (rather than an explicit) assumption of highway designers—the space between the points joined by a freeway is a social wasteland, devoid of human significance. This assumption is, of course, sometimes correct as in the case of purely industrial regions, or in undeveloped suburban or rural areas. Here, the only contact human beings have with the freeway is in using it for transportation purposes.

In somewhat more developed suburban regions, the assumption is still correct in a large portion of the cases, because the freeway can be effectively isolated from the residential spaces (26). However, referring to those very few impact studies which deemed it desirable to query residents' views of the freeways (and in each case, only suburban populations were queried), it is apparent that the freeway must be a considerable distance away from homes (200 to 300 ft) before those who consider it a nuisance are reduced to 25 percent of the population (39). A more developed Rhode Island residential community (6) through which a freeway was driven produced a large group of residents severely disturbed by the facility. A search of the impact literature failed to turn up a single instance in which an urban population was asked its opinion about a freeway in its midst. Nevertheless, from the data just presented, an extrapolation can easily be made. Urban residents living in greatest proximity to the freeway would have the greatest objections. These residents would present the greatest challenge to the assumption that freeways through urban areas run through social wastelands. Actually, these regions may be the locale for viable, cohesive communities, to which the residents have strong attachments. Although residents may state their objections in terms of the perceived noise, smell, and danger of the freeway, it is likely that the less obvious impact of physical disruption on the social structure will be more damaging (13, 14).

Not all residents living in close proximity to a freeway, however, will have the same kind or same degree of objections. Physical proximity is not the meaningful variable, unless it is directly coordinated to psychological proximity. Thus, residents whose use of the physical space surrounding their homes is restricted to a pathway function (streets are important only as a means of getting to or away from the home) will not be disturbed by freeway construction beyond the inconveniences of noise, smell, and danger. This is most likely to be found in highly urbane populations, living in apartment houses and oriented toward highly dispersed social spaces. These people are also likely to be high users of the freeway, and only occasional users of whatever open spaces are provided along its periphery.

Conversely, urban regions (particularly those that are most likely to be selected for freeway routes) are characterized by high concentrations of people who consider the space surrounding their homes as a living space to which they belong and in which they feel the comforts of a home. The space they are physically close to is the space to which they are psychologically attached.

A freeway traversing such a space is not traversing a social wasteland. It will be the purpose of this paper to suggest that the space and its social structure through which an urban freeway is to be constructed needs to be understood in great detail by the road designer both to avoid the harmful effects and to gain potential advantages that the freeway may have for the community.

All communities have the potential for social degeneration and blight. If the inadvertent placing of a highway helps to realize this potential, then the designer must bear the responsibility of having created more waste than a society can afford. On the other hand, if the highway can aid the community in acquiring some of the conditions of life that it values, then the designer is equally at fault if he does not discover how to produce these consequences. The time has long past when the luxury of a hit or miss approach to social planning can be afforded.

THE CITY AS A SOCIAL SYSTEM

The traditional view of the city includes a picture of the lonely, lost urban dweller, cut off from the norms and expectations of the small but stable village community, forced to lose his personal identity, and sinking in a sea of depression. This view of the nature of city life has persisted for some time, and was most recently elaborated on by Louis Wirth (40). This theorist was aware that not all urban residents were contemplating suicide. Some of them were establishing with their fellow residents very real interpersonal relations that had the character of true community behavior. But Wirth attributed this to a residual of rural living, so that right or wrong, he was again denying the city a capacity for spontaneously generating social support for its residents.

More recently social scientists have been taking a hard look at urban structure, using new and more sophisticated techniques (3, 4, 12, 22, 29). These investigators are now arriving at a rather different view. It is apparent that urban regions produce a wide variety of social structures and populations. Even the lowest income areas can generate integral systems of living that supply their residents with a good deal of personal satisfaction, a sense of neighborhood, identification with physical region, and a great reluctance to give up residence even with the inducement of better housing. These systems of living appear to vary according to the economic status of the families, the degree of family integration, and the degree of "urbanism" of the neighborhood (an index based on measures of the fertility of the families, rates of females employed, and the number of families living in single-family housing units). For example, lower-income urban groups tend to have a great reliance on their family and extended family for their informal relation (4) and they prefer to use the local economic, service, and recreational facilities of the neighborhood (17). Komarovsky found that urban dwellers have rather low (25 percent and lower as status decreases) rates of membership in voluntary associations (27). At the same time, it has been noted by several investigators (3, 5, 10, 12, 15) that, as there is less formal structure in the more urbanized community, there is an increase in the rate of informal "friendship" contact between local residents. Even when the contacts are based on formal role structures such as consumer-storekeeper relations, a significantly high proportion of the urban residents (particularly the lower-income groups) prefer to transform the relationship into a personalized, informal state of affairs (37). Lower status shoppers prefer to shop in smaller community stores where they were known by name and where informal relations with the store personnel could be established. The author does not mention the availability of credit buying in the local food store which must also be an important factor in shaping the preferences of these buyers. It can be concluded that the lower-income neighborhood can be an extended and complex social network involving geographically localized friends and relatives, many informal groups, and strong attachments to the community. Clearly, significant proportions of the urban population are on intimate terms with their immediately surrounding physical and social environment.

Also, positive feelings toward the neighborhood often develop despite inadequate housing facilities. Behind the slum lies not social chaos but a strong, satisfying community. This is an important point because it indicates the degree to which the residents of these neighborhoods are willing to tolerate difficulties in order to maintain the primary social relations of the community. Apparently this is a phenomenon present in many groups living in a satisfying social system despite generally inadequate housing. An interesting example of this can be found in the classic study of Festinger, Schachter, and Back (16) of a housing project built by Massachusetts Institute of Technology for married veteran students. The development consisted of U-shaped courts of from 8 to 13 single or semi-detached houses in each. The experimenters were interested in relating the physical features of the courts (the distance between houses and the direction in which a house faced) with the kind and rate of social interactions observed. For various reasons, the residents of these courts were generally very favorably impressed with life in the project. Very few expressed any desire to leave, more than one-half were vigorous in their statements that they would not consider leaving the project at all. Friendship rates were quite high, as were the rates of informal contact. This general satisfaction existed in spite of, and seemed to compensate for, many physical inadequacies of the houses. For example, at the time of the study, many of the houses had trouble with the roof so that moderate winds could raise them and allow rain to pour down the walls. The adequate and satisfying social life was sufficient to override these inconveniences. The authors report that the typical reaction was "Oh yes, there are many things wrong with these houses, but we love it here and wouldn't want to move."

Not all physically devilitated areas have such viable social structures within them, of course, but it ought not to be necessary to argue that the knowledge of the social system through which a freeway is to go is an important datum for those who plan and decide. This is all the more true when one considers that the attachment to the physical environs is probably greater among the lower-income groups than other strata, and that these groups live in areas most likely to be earmarked for freeway construction. That is, low-income areas appear to be the preferred places to locate urban freeways. The point of the present discussion is to warn highway planners to distinguish between slum-blighted areas, and low-cost areas. Seeley (36) has suggested a critical psychosocial distinction between them: the slum is an area in which there are pathological consequences for the residents wrought by the physical and social character of the neighborhood; i.e., the true blighted area. The low-cost area may be almost indistinguishable from the slum in terms of its physical facade, but it is a place whose physical inconveniences the residents will accept in order to gain the benefits of either low rent or the social satisfactions resulting from a sense of belongingness. This is a vital distinction, and one which the highway designer must recognize if he is to avoid making serious planning errors.

PSYCHOLOGICAL IMPACT OF PHYSICAL DISRUPTION

There have been few studies of low-income areas disrupted by large-scale physical change. No studies have yet been done in which the source of the physical disruption is the construction of a freeway. But one important study of the effects of an urban renewal program is brilliantly suggestive of the issues that must be resolved.

This series of papers describes the residents of the West End Section of Boston and their reactions to the destruction of the neighborhoods, mistakenly identified as a slum, and thus cleared. Fried (19), Fried and Gleicher (20), and Gans (21) describe the intense attachment of the residents to their neighborhood. This is the first study to establish the focus of positive loyalty to physical places (specific stores, houses, streets, etc.) as much as to the social environment of relatives and friends. The authors use the term "localism" to describe this kind of attachment to a space. It refers to a space that has the qualities of home but at the same time is public space in the sense that it is used by all residents for their various purposes. It may be thought of as an extension of home, with all the values of home. In the eyes of those to whom it is home, it is thus a space to live in rather than to pass through. It is typically composed of streets, hallways, roofs, alleys, stoops, and the fronts of stores.

Such a public space is the medium for the interaction of a great variety of people and functions. In this situation complex and intricate social systems develop. The physical aspect of the space is the framework on which the social systems are built. Although the authors limit this phenomenon to lower-income areas of high density, there is no doubt that other highly used spaces will generate social systems and the development of a strong sense of belongingness on the part of the resident of the space.

Disruption of the physical space has the potential of striking at the very foundations of the resident's sense of psychological well-being. When the residents of the West End were forced out, many of them exhibited what Fried (19) has likened to the clinical syndrome of grief. A depression similar to the experiences one has at the loss of a loved one seems to have persisted in some cases over a period of years. It should not be difficult to imagine that residents who continue to live in an area that has received such a crushing psychological blow will develop negative feelings about the eviscerated area. And it is the feelings that the residents have for their neighborhood which are the most important determinant of the social and economic value of the area. Social disorganization almost inevitably results in physical and economic disorganization, which ordinarily can be expected to spread to adjacent areas.

Hartman (24), in describing further the West Enders, reports an interesting method of estimating resident's reactions to generally shabby and in some instances dilapidated building conditions: an index of the physical condition of the tenants' apartments was constructed and compared to an index of the physical condition of the building. Surprisingly, almost one-third of the apartments were in considerably better condition than the buildings. Evidence that the residents devoted a good deal of care and attention to their apartments, despite the shabbiness of the general environment, should alert even the casual observer to question whether the usual objective criteria of substandard living can be appropriately applied in this case.

PHYSICAL DISRUPTION AND SOCIAL FUNCTIONING

There is a more immediate problem than that of the pervasive impact an urban freeway may have on a viable community: the effects on the surrounding area. The impact studies have little or nothing to say of this problem outside of describing the change in economic and population characteristics of the area. The few studies in which residents were asked their opinions of the freeway are largely irrelevant to this problem because it is apparent that physical spaces occupied by the freeways in these instances were not significant psychological spaces to the residents (26, 39).

One study by the Blair Associates (6) documents a point made by Wilfred Owen (32, p. 51): "The highway . . . can disrupt a neighborhood by thrusting itself between houses and recreational land, or between houses and schools." Blair Associates report that the highway removed four playgrounds, raised costs for police and fire protection because of the extra distances they had to travel, reduced the number of houses in the community by one-third, and increased the time it took the children to travel to school.

The implication of these points is that the highway is seen as a gap or a gash through the community and serves to separate people from each other and from the important facilities of the neighborhood. On the other hand, the gap itself has special characteristics, some of which have recently been described by two observers of the social and visual characteristics of urban space. First, Kevin Lynch, in an extremely insightful description of the visual qualities of the city (30) defines a sharp perceptual change in the layout of a city as an edge. This is an area that separates two regions, marking a sharp change in the characteristics of the regions on either side of the edge. There may or may not be the means to penetrate the edge from one side to the other. If such means exist, the edge becomes a seam, "a line of exchange along which two areas are sewn together." If such means do not exist, the edge is perceived as a barrier that serves to halt rather than enhance social functioning. A busy street, railroad tracks, an expressway, are all examples of barriers, whereas a park, accessible from both sides, can serve as a seam. Lynch's point is that the edge is perceptible as a barrier or a seam and will therefore serve to control behavior. Barriers will in effect repel and seams may attract.

In a similar analysis, Jane Jacobs, describes what she calls a border vacuum (25, ch. 14). Mrs. Jacobs places the emphasis on the functional rather than the visual properties of a region, and argues that when the functions that a region supports are curtailed, its utility is reduced. This in turn leads to still less use and consequently to the creation of a vacuum. A vacuum is used only by those who prefer it; i.e., those who wish to remain unseen or uncontrolled, such as criminals.

Mrs. Jacobs applies this concept to city streets that have had functions removed (e.g., streets along the edge of high-rise apartments and projects that are used only as paths), parks that offer only nonfunctional grass or asphalt walks, and stores with limited functioning (e.g., banks which close early in the afternoon). These are interesting speculations because they suggest a dimension of community space that might be causally related to the social integration of the community, and therefore related to the degree of personal satisfaction and community commitment of the residents of the area.

This analysis can be applied to the construction of large shopping centers where single-function impulse-buying shops are placed between two large multifunctional "magnets." This is necessary because few people venture very far from the highly active magnets, and this number decreases as the distance from the magnet increases. Single-purpose stores at the end of a line of stores in a shopping center apparently have a tendency to fail, whereas identical stores in the midst of the flow of buyers between centers of activity apparently thrive.

This might also be applied to a typical urban area cut by a limited-access freeway; for example, an intersection of streets in such an area before construction. Retail shops are located for a number of blocks along both sides of one street which runs perpendicular to the residential streets. Such an intersection is likely to be an active and populated subregion of the neighborhood throughout the better part of both the day and night. This is the magnet of the neighborhood, the social and economic center which is so popular that the traffic flow may not serve as a barrier between the four sides of the intersection. When this microcosm is replaced with a limited-access freeway, the consequence is not merely the reduction of population, business activity, and housing. The magnets that drew people and money to the region are gone. Multifunctions have been replaced by single-function streets. Activity suddenly halts a few hundred feet from the freeway and remains dormant until one reaches a few hundred feet beyond the other side of the freeway. Even a street that turns into a bridge across the freeway is a socially empty and useless object because its only purpose is to move cars away from the area. There is no reason to go to the intersection except to travel through it, or, because it is devoid of activity, to hide. Such an area becomes, in Lynch's terms, an edge, or in Jacobs' terms, a vacuum. In any terminology, it has become a negative place, quite capable of rapid degeneration.

CONCLUSIONS AND PROPOSALS

There are three major sources of negative consequences resulting from locating a freeway in the midst of an urban area: (a) the freeway may disrupt the physical framework on which the community is built; (b) the freeway may create a border vacuum capable of rapid degeneration; and (c) the freeway may serve to separate the residents from each other and from the important institutions and facilities of the neighborhood. These consequences are in respect to the residents who remain in the immediately surrounding environment and do not include the consequence of relocation of those who live and work in the path of the facility. These are both long- and short-term consequences and may not be easily identifiable by the residents themselves. However, they may be sources of serious unrest and discontent, long and costly public hearings and delay.

It would be appropriate to make some proposals at this point in order to achieve a level of constructive criticism. The psychosocial structures through which the freeways are to go need to be seriously considered in planning the facility, and such consideration will lead to improved, acceptable designs. The following are therefore proposed:

1. If some of the freeways that have been built in urban areas are examined the variety of communities through which they have been placed may be noted and the range of consequences that have been produced may be imagined. It is not necessary to be a sophisticated observer of the social scene to estimate where and what kinds of disruptions of social functions have taken place. It is possible to increase one's sensitivity to the social requirements of communities by simply looking.

2. Some social science research should be included in present plans. Sociological and social psychological methods for measuring social structure are sophisticated enough at present to allow for an adequate before-and-after experimental design (1, 18, 23, 29). Both experimental and statistical techniques are available so that the contribution of a freeway to social change can be reasonably distinguished from most other factors contributing to the change. In other words, the concept of an impact study needs to be expanded. Parallel studies are needed in the social psychological disciplines, similar to those in the economic and demographic disciplines. Until the psychosocial consequences of actions are known, the environment cannot be fully controlled.

3. Before a freeway is built, its locale should be studied with respect to some of the following: (a) the social boundaries of the communities involved; (b) the major social needs of the residents; (c) the important social functions carried out in the neighborhood; and (d) the critical spaces within which these functions and needs operate. Above all, these should be done in cooperation with the residents.

With these data, it will be possible to minimize the disruptions at least because meaningful criteria of route location will be established. Equally important, however, is that it becomes possible, with these data, to identify the necessary disruptions in advance, and to plan for their reduction before they are created. For example, these data can suggest where and how the community must be shielded from the freeway. They can also suggest in advance which functions of the community are most in need of maintenance. Thus, if a highly used space is to be cut by the freeway, then it is apparent that the facilities for these uses should be recreated as part of the freeway structure, with easy accessibility for all residents. The roadbed might be sunken, in this case, and the functions (retail buying, recreational activities, restaurants and bars, etc.) placed on top of the freeway. This could also act as a bridge between the two sides of the road. In this manner, those critical magnets could continue to hold the neighborhood together. Without this support, such a community could easily begin to die.

REFERENCES

1. Arensberg, C. M., "The Community-Study Method." Amer. Jour. Sociol., 60: 109-124 (Sept. 1954).
2. "Socio-Economic Factors and the Inner Belt." Associated Industries of Mass., Economic Research Department, Boston (1961).
3. Axelrod, M., "Urban Structure and Social Participation." Amer. Sociol. Rev., 21:13-18 (Feb. 1956).
4. Bell, W., and Boat, M. D., "Urban Neighborhoods and Informal Social Relations." Amer. Jour. Sociol., 62:391-398 (Jan. 1957).
5. Bell, W., and Force, M. T., "Urban Neighborhood Types and Participation in Formal Associations." Amer. Sociol. Rev., 21:25-34 (Feb. 1956).
6. "The Friendly Interchange: A Planning Study of Interstate 95 and the Huntington Avenue Expressway as They Affect a Community in Cranston, Rhode Island." Blair Associates, Providence (1960).
7. Bright, D., "The Effect of Limited Access Expressways on Existing Street Systems: A Bibliography." HRB Bibliography Series 1, (Jan. 1947).
8. Caplow, T., and Forman, R. E., "Neighborhood Interaction in a Homogeneous Community." Amer. Sociol. Rev., 15:357-366 (June 1950).
9. Dansereau, H. K., "Some Implications of Modern Highways for Community Ecology." G. A. Theodorson (Ed.), "Studies in Human Ecology." Row Peterson (1961).
10. Dean, J. P., "The Neighborhood and Social Relations." Forum on Neighborhoods Today and Tomorrow, 3:4, Philadelphia Housing Association (April 1958).

11. Dewey, R., "A Critical Look at Freeways to Downtown Areas." Amer. City, 70: 153, 155 (Jan. 1955).
12. Dotson, F., "Patterns of Voluntary Association Among Urban Working-Class Families." Amer. Sociol. Rev., 16:687-693 (Oct. 1951).
13. Duhl, L. J., "Mental Health and Community Planning." Planning 1955, American Society of Planning Officials, Chicago (1956).
14. Duhl, L. J., "Planning the Physical Environment." HRB Bull. 190, 20-24 (1960).
15. Fava, S. F., "Contrasts in Neighboring: New York City and a Suburban Community." W. M. Dobriner (Ed.),"The Suburban Community." Putnam (1958).
16. Festinger, L., Schachter, S., and Back, K., "Social Pressures in Informal Groups: A Study of Human Factors in Housing." Harpers (1950).
17. Foley, D. L., "The Use of Local Facilities in a Metropolis." P. Hatt and A. J. Reiss (Eds.), "Cities and Society." Free Press (1957).
18. Form, W. H., et al., "The Compatibility of Alternative Approaches to the Delimitation of Urban Sub-Areas." Amer. Sociol. Rev., 19:434-440 (Aug. 1954).
19. Fried, M., "Grieving for a Lost Home." L. J. Duhl (Ed.), "The Environment of the Metropolis." Basic Books (in press).
20. Fried, M., and Gleicher, P., "Some Sources of Residential Satisfaction in an Urban Slum." Jour. Amer. Inst. Planners, 27:305-315 (Nov. 1961).
21. Gans, H. J., "Human Implications of Current Redevelopment and Relocation Planning." Jour. Amer. Inst. Planners, 25:15-25 (Feb. 1959).
22. Greer, S., "Urbanism Reconsidered: A Comparative Study of Local Areas in a Metropolis." Amer. Sociol. Rev., 21:19-25 (Feb. 1956).
23. Greer, S., and Kube, E., "Urbanism and Social Structure: A Los Angeles Study." M. B. Sussman (Ed.), "Community Structure and Analysis." Crowell (1959).
24. Hartman, C., "Social Values and Housing Orientation." Research Document 19, Center for Community Studies, Boston (1962).
25. Jacobs, J., "The Death and Life of Great American Cities." Random House (1961).
26. Kelly, J. F., "Residences and Freeways." Appraisal Jour. 25:505-520 (Oct. 1957).
27. Komarovsky, M., "The Voluntary Associations of Urban Dwellers." Amer. Sociol. Rev., 11:686-698 (Dec. 1946).
28. Kuper, L., "Social Science Research and the Planning of Urban Neighborhoods." Social Forces, 29:237-243 (March 1951).
29. Lazarsfeld, P. F., and Merton, R. K., "Friendship as Social Process: A Substantive and Methodological Analysis." M. Berger et al. (Eds.), "Freedom and Control in Modern Society." Van Nostrand (1954).
30. Lynch, K., "The Image of the City." Technology Press (1960).
31. Nash, W. N., and Voss, J., "Analyzing the Social-Economic Impact of Urban Highways." HRB Bull. 268, 80-94 (1960).
32. Owen, W., "Cities in the Motor Age." Viking (1959).
33. Pillsbury, W. A., "The Economic and Social Effects of Highway Improvement: An Annotated Bibliography." Virginia Council of Highway Investigation and Research (1961).
34. Ravitz, M. J., "Use of the Attitude Survey in Neighborhood Planning." Jour. Amer. Inst. Planners, 23:179-183 (1957).
35. Rubin, M., Orzack, L. H., and Thomlinson, R., "Resident Responses to Planned Neighborhood Redevelopment." M. B. Sussman (Ed.), "Community Structure and Analysis." Crowell (1959).
36. Seeley, J. R., "The Slum: Its Nature, Use and Users." Jour. Amer. Inst. Planners, 25:7-14 (Feb. 1959).
37. Stone, G. P., "City Shoppers and Urban Identification: Observations on the Social Psychology of City Life." Amer. Jour. Sociol., 60:36-45 (July 1954).
38. Thiel, F. I., "Social Effects of Modern Highway Transportation." Public Roads, 32:1-10 (April 1962).
39. "Traffic Impact: A Study of the Effects of Selected Roads on Residential Living in Southern Westchester." Westchester County Department of Planning, White Plains (1954).
40. Wirth, L., "Urbanism as a Way of Life." Amer. Jour. Sociol., 44:1-24 (July 1938).

Discussion

SIDNEY GOLDSTEIN, Bureau of Public Roads—I want to correct an erroneous impression I think Dr. Cline has about the kind of research that has been done by various States, institutions, universities, and the Bureau of Public Roads.

It is true that most economic impact studies today deal with such things as land values and land use. However, any number have associated with them psychologists and people in other social sciences. The Penn-Jersey State Study has associated with it a very heavy sociology group dealing with such things as power structure, community complexity, and the purposes of different people in the community.

The Inner Belt Study in Boston was quite concerned with such things as the removal of churches, playgrounds, etc., and made comparisons in terms of such things.

The impact of traffic on urban areas—this by the University of Illinois at Champaign—was also concerned with individual streets and the relationship to noise, etc., to the people in the area. I could go on and on. Professor Goldstein of Brown University has made findings on these matters in some relocation studies. The origin and destination studies deal with all sorts of information available to transportation planners, with relationship to choice of transportation to different types of social activities.

MARVIN G. CLINE, Closure—I am on the whole familiar with the literature and studies you have mentioned and do not believe the methods or data of these studies are relevant to the problems and ideas of social structures that I am raising here.

The View from the Road

DONALD APPLEYARD, KEVIN LYNCH, and JOHN MYER,
Respectively, Assistant Professor of Urban Design, Associate Professor of City Planning, and Assistant Professor of Architecture, Massachusetts Institute of Technology

• THIS PAPER deals with the esthetics of urban highways: the way they look to the driver and his passengers, and what this implies for their design. The authors became interested in the subject out of a concern with the visual formlessness of American cities and an intuition that the new expressway might be one of the best means of re-establishing coherence and order on the metropolitan scale. Also, the highway offers a good example of a design issue that is typical of the city: the problem of designing visual sequences for the observer in motion.

Ugly roads are often taken to be a price of civilization, like sewers or police. The boring, chaotic, disoriented landscape, which seems to be the natural habitat for the American automobile, is tolerated with resignation by the highway user. Even those who are alarmed by the ugliness of the roadways emphasize the repression of vice: roads should melt into the landscape; billboards should be controlled; the scars of construction should be disguised by planting. There is little discussion of turning the highway experience to any positive account.

Yet roadwatching can be a delight. There are many journeys that are enjoyable in themselves: walking, horse-back riding, boating, rides in amusement parks, or on open bus tops. There are even a few roads in this country on which driving a car is a pleasure.

In an affluent society it is possible to choose to build roads in which motion, space, and view are organized primarily for enjoyment, like a promenade. But on highways whose primary function is the carriage of goods and people, visual form is also of fundamental importance and can be shaped without interfering with traffic flow. It is the landscape seen from these workaday urban highways that will be discussed here from the standpoint of the driver and his passengers; for the purposes of this analysis the issue of how the highway looks from the outside will be ignored.

The studies were begun by traveling repeatedly along several expressways, particularly the approaches to New York, Hartford, Boston, and Philadelphia. Tape recordings, films, photographs and sketches were used to record everything that the researchers found themselves looking at. Subsequently, an analysis was made of this experience, which was checked by analyzing the reactions of a group of twenty people riding along Route C1 in Boston, and a graphic language developed with which to describe it. Finally, this language was refined by using it in designing two hypothetical freeways. This paper presents some of the most general conclusions, neglecting the supporting data, the illustrative material, and the techniques for analysis and design that were also developed.

The highway experience varies with the user. The tourist sees the landscape with a fresh eye; he attaches relatively few personal meanings to it, but is urgently engaged in orienting himself within it. The commuter, or other habitual user of the road, is more likely to ignore larger landscape features, in favor of activities, new objects, or the moving traffic of the road. The driver must watch the scene constantly; his vision is confined to a narrow forward angle and focuses on the events in the road itself. His passenger is freer to look or not to look, has a wider angle of vision, and is not necessarily concerned with immediate traffic. Both driver and passenger are likely to be an inattentive yet captive audience that cannot avoid remarking, if only subconsciously, the most dramatic events of a scene that is too mobile and too dangerous to be ignored.

Paper sponsored by Special Committee on Urban Transportation Research.

The modern car interposes a filter between the driver and the world he is moving through. Sounds, smells, sensations of touch and weather are all diluted. Vision is framed and limited; the driver is relatively inactive. He has less opportunity to stop, explore, or choose his path than does the man on foot. Only the speed, scale, and grace of his movement can compensate for these limitations.

The highway experience has some further special characteristics. It is usually reversible; people may traverse the road in either direction. In addition, it is serial and overlapping; people enter and leave the highway at intermediate points.

The driving experience can be described as a sequence played to the eyes of a captive, somewhat fearful, but partially inattentive audience, whose vision is filtered and directed forward. It is a sequence that must be long, yet reversible and interruptible.

The surveys tended to confirm the obvious regarding the identifiable objects or elements of attention. Along two routes, between one-half and two-thirds of all front-seat sightings were straight ahead. Along another route, two-thirds of these impressions were caused by the near, apparently "moving" objects, rather than the far, seemingly "stable" ones. They included the color and texture of the road surface, objects at the shoulder, signs, guardrails, retaining walls, etc. Even in periods of wide scanning, attention regularly returns to the road itself. It is concentrated particularly on the foreground at points of decision, or in sharply constricted spaces. But after such experiences the larger landscape is scanned with a fresh eye. This is a moment for visual revelations, when one is sure of an audience attentive to large effect.

Beyond this concentration on near detail, the fundamental sensation of the road, continuously referred to, was the sense of motion and space. This includes the sense of motion of self, the apparent motion of surrounding objects, and the shape of the space being moved through.

The sense of motion of self is perhaps the primary feeling. True kinesthetic sensations are slight in a steadily moving car on a modern highway. The driver receives some cues from his controls, but if the passenger closes his eyes it is very difficult for him to distinguish steadily held turning movements, levels of speed, or even gentle climbs or descents. Bodily sensations become strong only at points of abrupt change in speed or in angle of climb and fall.

Automobile riders depend on vision to give them a sense of the motion they are undergoing. They interpret the apparent motion of surrounding objects that they know to be fixed to be the result of their own progression. These clues may include the passage of roadside detail, the apparent rotation of near objects around far objects, the seeming outward radiation of detail and textures from the point dead ahead, and the illusion of growth as objects approach.

Where surrounding objects are far off, or few, or featureless, or moving with the vehicle, then the sensation is one of floating, of no forward movement. This can be temporarily a pleasant relief, but the inability to reach any goal can soon lead to boredom. Objects might, in such a case, be placed alongside the road, just to reassure the driver about his real motion.

The sense of varied motion is inherently enjoyable if continuous and not too violent. The rhythmical humping of the turnpike across the New Jersey flats, or the sweeping turns of the approach to Boston over the Mystic River Bridge possess such a quality.

The road alignment generates the motion of the driver. Because it predicts future movement, the shape of that line is always of compelling interest. In previous highway studies, this perspective view of the alignment has been considered paramount, along with landscaping and control of roadside detail. The "flowing" line now generally preferred is one sound technique for gaining a harmonious effect. But it is a technique rather than a principle. A kink, a sudden shearing off, a long straight slash may sometimes be part of the artistic content.

The apparent motion of objects can become a delight in itself. The welling up, splitting apart, and falling away of objects can become intricate dances when groups are seen together on a road of complex alignment. Landmarks may move across a background, rotate one way, then another, disappear and reappear, coincide or disperse. The road itself may feint, jog, swerve, or slide past them.

The distant view down the axis of a road, on which the driver can fix his attention without losing touch with his path, is a static experience. If the road is also sloping down at this point, it may be possible to present a view that is meant to be looked at carefully, and that in some way epitomizes the city or an important part of it. Such classical views as San Francisco across the Bay, or New York across the Hudson, are important experiences. Occasionally, when the road makes a sweeping turn or the view is very restricted, the visual field becomes a dynamic one, rotating, rushing, or growing. This is a powerful if unsettling effect.

Things in the landscape that are also in motion, together with their paths of movement, exert a corresponding fascination. The driver will compare his own trajectory with that of a distant train, the ascent of an airplane, the progress of a ship; or relate his path to railroad lines, canals, and other roads which may parallel, interlock, intersect, pass over or under his own. Most impressive of all is the movement of accompanying traffic, which may be the principal visual impression for a commuter.

Simultaneously with the appreciation of objects in motion, there occurs the sense of space, which is basically one of confinement and of the dimensions of that confinement. The space may vary proportionately, through the character of defining walls, objects in the space, or by the position of the observer in that space. The driver can be low down in a concave space, high up in a convex space. The space may be narrow or wide, the walls solid, transparent, netted, smooth or jagged, filled with traffic or deserted.

In sequence, there can be dramatic contrasts between confinement and spatial freedom, such as the entry into Hartford from the Wilbur Cross Parkway, where the road descends towards the city, sinks into a cut, passes through a short tunnel, and bursts out into the central park.

One of the most important visual sensations is the relation of scale between a large environment and the observer, a feeling of adequacy when confronted with a vast space. The automobile with its speed and personal control begins to reduce the disparity in scale between man and the city, allowing man again to feel powerful and big enough to relate to his environment. The design of the vehicle as an extension of man, therefore, becomes a critical factor in his experience.

At the next level of organization the driver is engaged in orienting himself to the environment, in building up some image of it. Movement along the road consists of a succession of approaches to goals, which may be prominent landmarks, focal points, or other paths to be attained. By them he measures his progress and foretells his future. They may be distant goals that symbolize his final destination, or they may be nearer objects that divide the road into visual segments.

Goals may be organized in succession, as on the prairie when one proceeds from silo to silo. They may overlap, or there may be one dominant goal constantly visible, with minor goals playing against it. Thus the towers of Manhattan indicate the eventual destination of the New Jersey Turnpike while it maneuvers through the monumental landscape peopled by oil refineries, the Newark Airport, and the Pulaski Skyway.

Beyond the sense of progression from goal to goal, one is concerned with orientation in the general environment, with locating its principal features and relating oneself to them. This is partly a practical, partly an esthetic activity. A clear image of the city structure is a necessary counterpart for driver orientation on the urban freeway. Reliance on signs is not enough. There is positive pleasure in being able to recognize the urban scene and fit it together.

The shapelessness of Boston from the Mystic Bridge approach, and the frequent periods of orientation blindness are disappointing and disquieting, whereas the edge of Manhattan, from either the East or West River Drives, is satisfying just because the relationship between city and water is made visible.

The image of the highway itself may also be clarified. Successive sections may be visibly differentiated so that they can be recognized as distinct parts. Thus the motorist can see that he is "in the hilly part" as well as "approaching the center." The general alignment may be made to appear as a simple geometric form. Continuities of edge, surface, or rhythm may be used. Typical sequences and gradients may be developed, and the sequence in one direction may be made recognizably different from the sequence in the other. The road ahead may be exposed and strategic points may

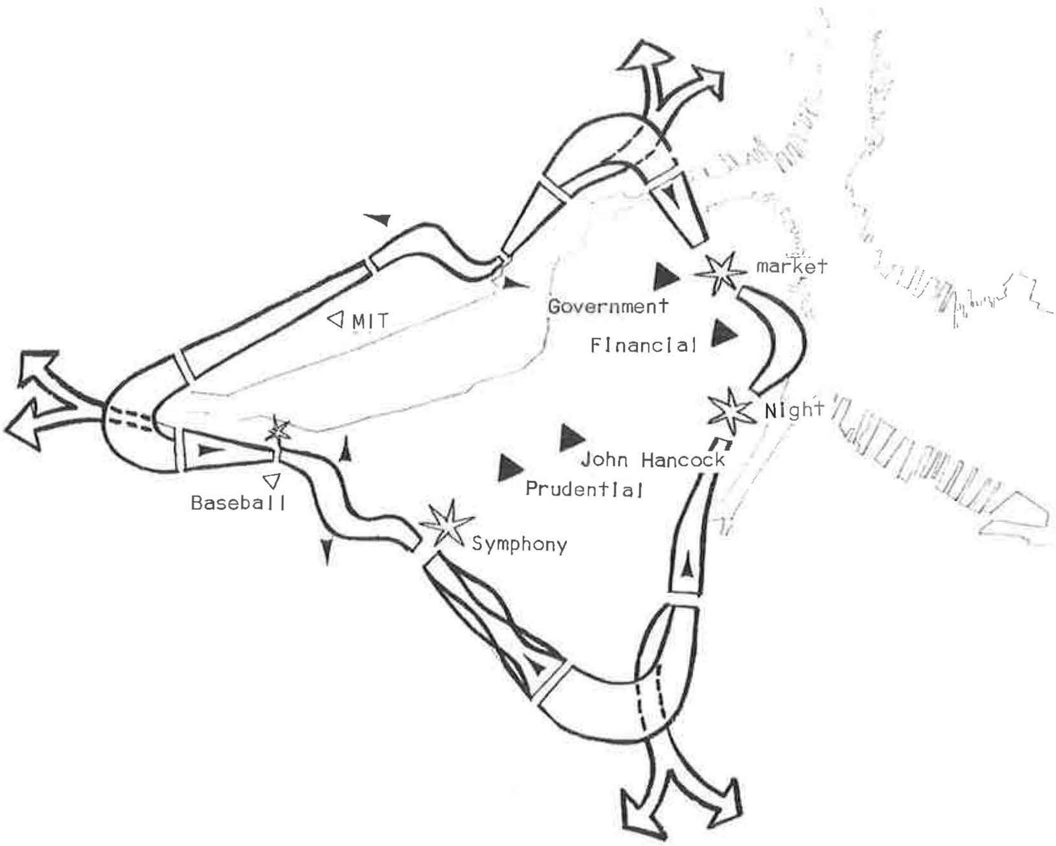

Figure 1. Inner belt expressway, Boston; structure of road.

be articulated. The form of interchanges may be clarified, so that driving decisions become self-evident and the shape is congruent with the principal flow of traffic.

Finally, the driver seeks meaning in his environment. He relates the visible objects to the stock of ideas in his mind. Such visual clues as the sight of an activity are essential to comprehension of the city. When the road makes apparently purposeless movements, or when a lively center of activity like Boston's food market is hidden from the road that passes overhead, an opportunity for contributing to an expressive environment is lost. Current efforts to "buffer" fast roads from the city by depression, distance, or landscaping are reducing the road experience to dull meaninglessness.

Would it be possible to use the highway as a means of education, a way of making the rider aware of the functioning, history, and human values of his world? The highway could become a sequential exposition of the city, by visually relating it to focal points, and picking out symbolic and historical landmarks. Travel guides, tape recordings, and signs, if imaginatively executed, could point out the meaning of the scene.

The most powerful experiences occur when space, motion, orientation, and meaning reinforce each other—when a landmark that is rooted in community history is the visible goal of a journey and the visible pivot about which the road turns. The pivot of motion on a highway today is all too likely a temporary shanty, and its goal a whiskey advertisement.

Using all these elements the basic artistic problem of the highway is the shaping of its sequential form. In such form the principal aim is to preserve continuity while developing, embellishing, and contrasting the material. The road itself furnishes an essential thread of continuity, but it must be supported by successions of space, motion, orientation, and meaning which become parts of a connected whole. An overlapping of

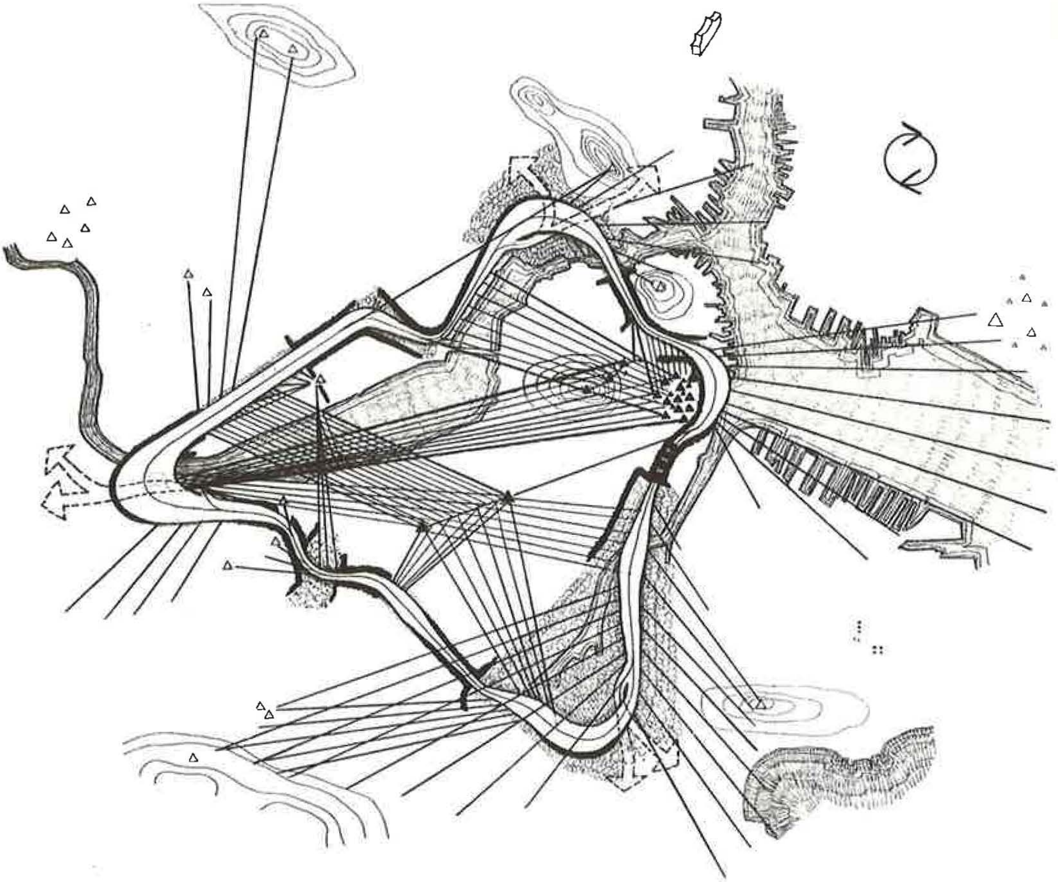

Figure 2. Clockwise route.

goals may do this, the repetition of previous movements, or a basic rhythm of attention.

The tempo of attention appears to be a sensitive index of the quality of a road. Where this tempo is rapid, attention concentrates on near objects straight ahead on the road; where the tempo is slow, scanning takes place. When either of these is prolonged, a sense of oppression or boredom occurs. Perhaps there is an optimum range for this time interval between strong impressions. Were this true, the roadscape should possess a basic, though varying, beat.

The traditional sequential form is to set in motion a drive toward a final goal. This drive may be interrupted, prolonged, and embellished at rhythmic intervals, but it never entirely loses forward momentum, and it achieves its destination at a climax, subsiding then to a conclusion with tension resolved. This is a useful model for highway design but it suffers from the handicap that the audience enters and leaves at different points. Thus, sequential form may have to be more like a magazine serial, with self-contained episodes, or it may have to be symmetrical with climaxes at both ends for a two-way aduience, or the unified climactic form may have to be abandoned for the articulated but "endless" composition of the kind typified in jazz.

The principal objectives in shaping the highway visual experience may now be summarized. The first is to present the viewer with a rich, coherent sequential form, a form that has continuity, rhythm, and development, and that provides contrasts, well-joined transitions, and a moving balance.

The second objective is to clarify and strengthen the drivers' image of the environ-

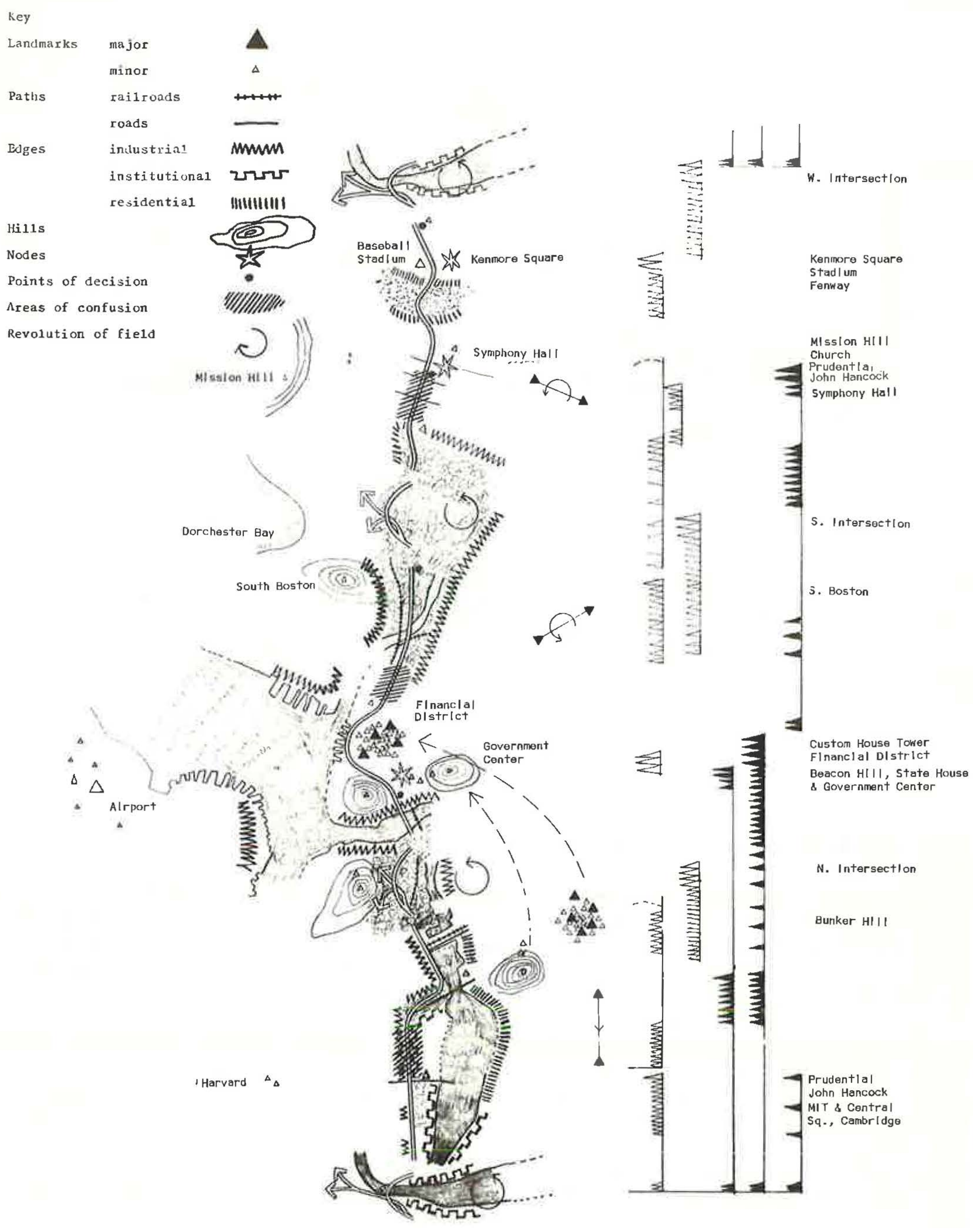

Figure 3. Orientation diagram to be read from bottom to top.

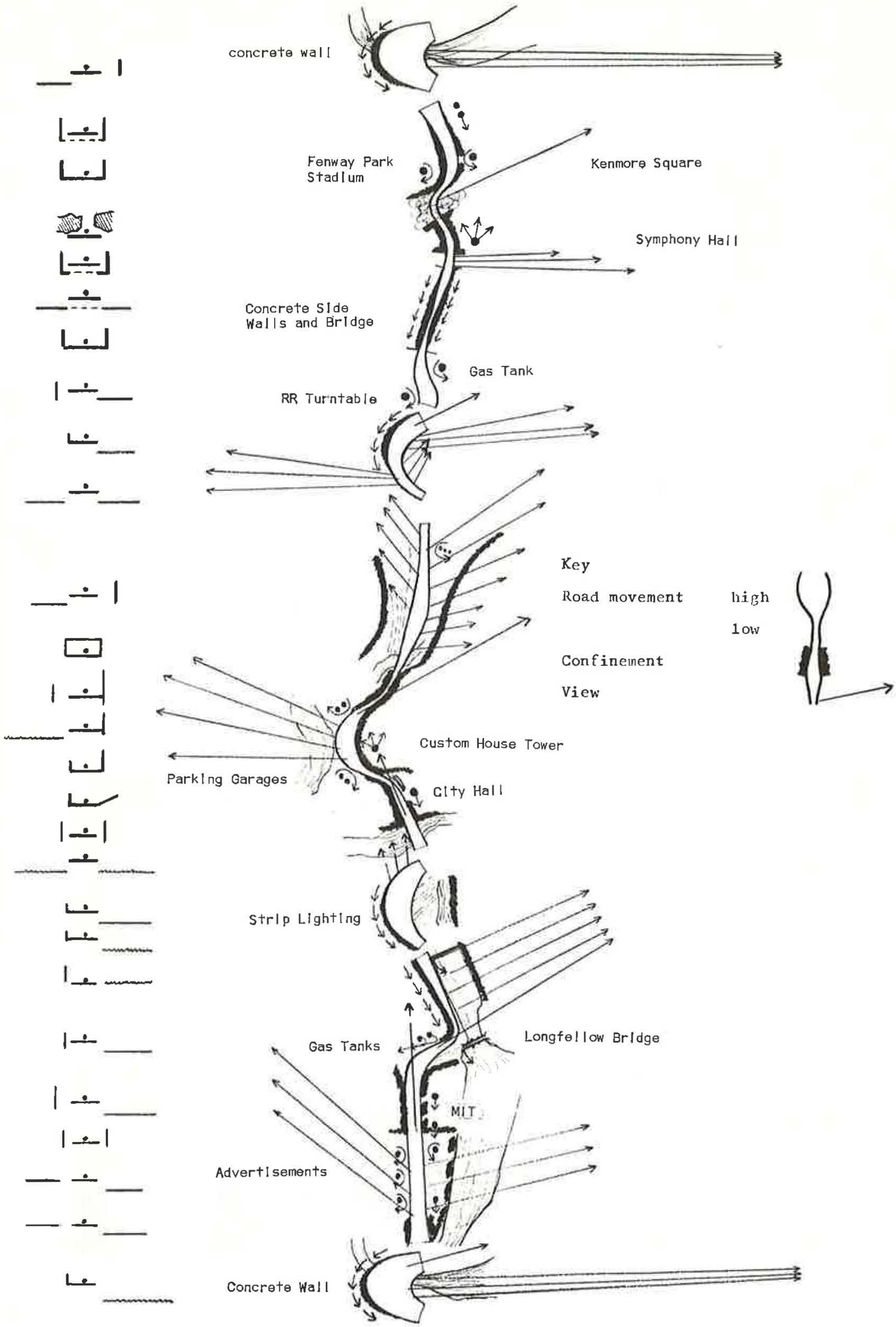

Figure 4. Space-motion and view diagram.

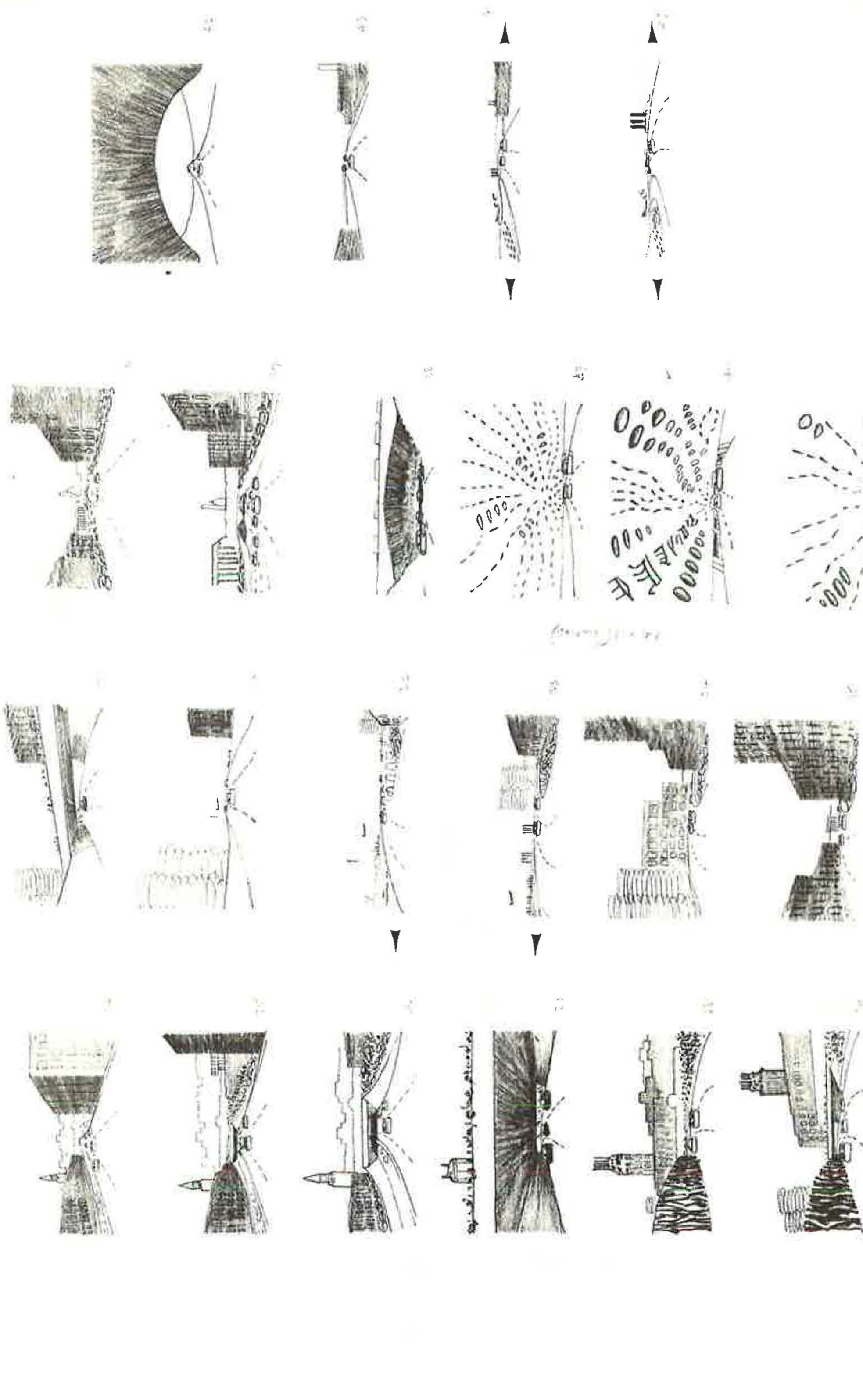

Figure 5. North-south sequence on Centerway.

ment, to give him a picture that is well-structured, distinct, and as far-ranging as possible. He should be able to locate himself, the road, and the major features of the landscape, to recognize those features with surety, and to sense how he is moving by or approaching them.

The third objective is to deepen the observer's grasp of the meaning of his environment—to give him an understanding of the use, history, nature, or symbolism of the highway and its surrounding landscape. The roadside should be a fascinating book to read on the run. Ideally, all three objectives should be achieved by means that interlock at every level.

These analyses are still fragmentary. It would be useful to study further the experience of the commuter, the problems of transition, the design of terminals, and the view of the highway from outside. Neither the design of highway networks nor the whole system of movement in the city has been considered. Both await the efforts of future research.

To illustrate some of the implications of the study, Figures 1 through 5 show a hypothetical design for Boston's inner belt expressway. Current plans locate this route in a loose and shapeless ring about the downtown, often too far out and suppressed to maintain orientation or visual contact with the center, and connected only sporadically to the incoming radials.

The redesigned road sets out to clarify three aspects of the environment for the road user: (a) the natural features (in this case, the harbor, rivers, and hills around Boston); (b) the functional pattern of the city, particularly downtown; and (c) the structure of the freeway system itself.

Boston's present image has many weaknesses which this road may help to eliminate. The location of water is confusing. The Charles River lacks continuity with the harbor, which itself is seldom seen. Almost the whole south side of downtown, an area of extensive railroad yards and industry, fades in the image; in fact the entire area surrounding the peninsula suffers from the inner ring "grayness" that characterizes almost every American city. There are also potentialities in the image. From the air or on a map, Boston possesses a formal clarity that is not apparent on the ground. Large open spaces that surround the peninsula might provide excellent viewing points were they accessible, and Boston's internally distinctive districts could help to create a highly differentiated and comprehensible image were their character exposed to the view from the road.

To overcome the difficulty of orienting on a circular route, three major intersections, leading to North, South and West radials are proposed. These intersections, acting as strong forms in confused areas of the city, become apexes of a triangle, the sides of which are visually associated with that part of the city being traversed. They are called the Riverway, Centerway, and Crossing, and each possesses a central climax. The Riverway parallels the Charles River at some distance, then, at the center, kinks inward and downward to the water's edge with cross-views to Cambridge and the State House, before continuing its parallel course beside the river. The Centerway is directed towards the financial and shopping district with a central outward curve around the financial district allowing views across the harbor to the airport. This curve is articulated at both ends by descent into areas of visible activity—to the north, Boston's Italian market; to the south, through the Dover Street tunnel, where a tunnel restaurant is proposed. The Crossing passes quietly through residential areas except for a curving stretch through Fenway Park with Kenmore Square and the baseball stadium to the northwest, and a new symphony hall square to the southeast.

The whole route contains a simple basic rhythm of intersection-climax-intersection which is overlaid by another rhythm marked by the two major downtown destinations: (a) the financial district, government center, and retail shopping around the Hub, and (b) the new Prudential-John Hancock complex around Copley Square. These major goals are picked out for viewing with regular frequency and alternating emphasis along the route, so that eastern travelers relate to the Hub, western travelers relate to the Prudential-John Hancock group. Within these major rhythms lie those of secondary goals, particularly those of outlying centers (South Boston, Mission Hill, Cambridge, Somerville, Charlestown and Logan Airport) that provide rhythms of inside to outside viewing. (These and other aspects of the design, such as location of advertising, parking garages, the night scene, and road detail are described more extensively in the monograph. The drawings illustrated employ a notation system, which was developed to describe existing routes.)

This whole study was motivated by the promise of the new world of vision inherent in the speed of movement, and by a desire to find a visual means for pulling together large urban areas. The crucial test will come in applying these ideas to actual design problems, and in evaluating the results obtained. Not only would one learn much of technical interest from a serious attempt in this direction, but a road built for vision in motion would be a concrete example of what the highway experience could be, an example far more powerful and evocative than any number of paper projects. Might it be possible to construct such a road as a national experiment?

ACKNOWLEDGMENTS

This paper is a brief extract from a monograph of the same title to be published shortly by the M. I. T. Press for the M. I. T. -Harvard Joint Center for Urban Studies.

Summary Remarks—Session I

HARMER E. DAVIS, Director, Institute of Transportation and Traffic Engineering, University of California

•IN ITS SESSIONS this year, the Committee on Urban Transportation Research has begun an inquiry into a most difficult problem; namely, community values as affected by transportation. The presentations scheduled in this session, and even in both sessions, are but a bare sampling of the ramifications of this diffuse subject. Thus a simple resumé of these papers would not appear to add much to what has been presented. Possibly, however, some comments relating to the general nature of the problem, as a backdrop against which to offer some thoughts generated by a reading of the papers, may serve to give some interim perspective.

One would expect to find a rather broad interpretation of the idea of "community values."

The concept of "values" is taken to include a range of things deemed to be intrinsically desirable by society. Within this range one may well expect to find conflicting values. Some values society will hold in higher esteem or priority than some lesser values.

In the concept of "community" is read the notion of an interacting populace whose size and composition may vary, depending on the common thread of interest under consideration. Thus, at one end of a scale the focus may be on the neighborhood as a community in which the common thread seems to derive from rather local and intimate social interaction, and sense of "belongingness," as Mr. Cline put it. At the other end of a scale, it is conceivable that a whole nation or group of nations may comprise a community; here there may be a common thread of interests and desires related by economic or cultural ties, or perhaps generated by a mutual interest in survival; here there may be community values which, in situations of conflict, may completely overshadow some of the values derived from localized interests.

In between is the community having the dimensions of an urbanized or metropolitan region; this is the community Messrs. Colwell and Zwick were talking about, and they implied that this regional community is at once the product of, and the key functional unit of "society U. S. A." in the present stage of economic development. They seem to take the urban region as the significant unit of organized economic activity.

That a profound change has been taking place in the arrangement and distribution of activities in the urban regional community is, of course, no news. It has been variously regarded with interest, glee, despair, anger, frustration, and amazement.

Most observers and analysts have no trouble in agreeing that the changes occurring in the organization of urban regional communities result from a combination of economic forces and the responses thereto by society. Zwick makes the point that at this stage in economic development, the provision of new transportation facilities and services no longer uniquely leads or dominates economic development as a whole, but that the growth and disposition of economic and social activity is in large measure influenced by forces in the economy other than transportation. Colwell seems less than positive about this thesis. The question may be raised as to whether or not this may have important implications for those who would hope to restore the city of a former day by simply supplying again a transportation service in the pattern of that day.

There seems now to have been a move into an era when it is being judged desirable and appropriate to give more forethought to how urban regional complexes are arranged and function. This process of taking forethought is variously called "planning." It appears to be induced by a growing conviction that the values of a random, undirected process of development are inferior to those of a planned process of development of living and working space in urban communities.

Possibly one reason there has been so much argument and altercation about the merits of planning the development of the urban regions is that it is only recently that an attempt has been made to learn how to do it. Maybe the effort to learn has been difficult, in part, because it has not really been understood how the urban complex grows, functions, and changes, in response to longer-term economic forces.

Both Zwick and Colwell make the point that a key aspect of transportation planning in the future will be a problem of meeting the demand for mobility in an economic community being conditioned by a variety of other economic forces. Zwick emphasizes that quality of transport services and a better understanding of consumer preferences (values) will be important to the planning of future transport systems.

In any planning (or design) process, the planner (or designer) strives for a solution which meets some acceptable combination of qualities or requirements. A compromise is nearly always involved; this is where the art aspect of planning or design comes in. The qualities, or requirements, or criteria, or standards of design (or operation) result from values, some measurable and some not, that are placed on the performance of whatever it is that is being planned or designed.

With regard to transportation, society, in the first instance, values certain levels of physical performance and safety in its transportation systems. By trial and error, through the ingenuity of the technical designers, and through the functioning of the market place and the grinding of the political processes, acceptable standards of performance of the transportation systems evolve. It is these requirements of physical performance that the planner-designer must satisfy first, and these were the first with which he historically acquired proficiency.

Society also places value on the non-prodigal use of the scarce resources available to it. Thus, various criteria of economic feasibility are used by the planner-designer. He early learned that if he was oblivious to these values, the job did not get undertaken.

Society places value on various qualities of transport service. There are many aspects of the quality of service; the values involved no doubt have priorities which are influenced by the affluence of the particular community. Among the numerous considerations, for instance, is the avoidance of undue crowding or congestion.

To avoid congestion, the capacities of the parts of a system are adjusted to demand. In recent years, planners of urban transportation systems have been giving considerable attention to this element, and have been becoming more adept at predicting capacities needed to serve traffic generated by various elements of the community.

There is currently a move into a period where the community seems to be indicating that there are further categories of values to which it would like to have some consideration given. One seems to be a set of values held by citizens of the community in the role of travelers, and the other seems to be a set of values held by citizens when occupying a role other than traveler. It is of interest to note that we are concerned with practically the same community of citizens, but the values they highlight depend on their role of the moment.

One set of values, from the viewpoint of the traveler, stems from aesthetic considerations. There has been increased consideration of some aspects of this set of values, over the years. But Appleyard, Lynch and Myer have provided a refreshing essay on how things look from the road, at least to some of the more consciously perceptive and sensitive members of the community. They have suggested one rationale for approaching the study of values of this sort.

Cline has presented a set of considerations pertaining to some "off-the-road" values. There are, of course, a variety of "off-the-road" considerations other than physical topography and the costs of lands or improvements which may influence the planner-designer. For example, in locating routes he usually avoids city halls, cemeteries, and governor's mansions. But as society increases in affluence and humaneness (at least at the micro- if not at the macro-scale), other considerations are becoming, or may become, delineated. For example, the presence of historical monuments has influenced planning decisions. Cline has summarized some of the thinking with regard to what might be called sociological or cultural topography. His suggestion that attempt be made to recognize more clearly and to respect the functional neighborhood unit, is a consideration to which some transportation planners have already given some thought. Through sociological studies, such as those he cites, possibly the values here to be given consideration can be more clearly delineated.

In closing, an earlier observation is iterated that, even as an unprecedented urban form seems to be evolving, so understanding of its functions, and planning with respect to its needs, are also evolving. It is, and will be, a team job to develop both this understanding and the planning competence.

The Committee on Urban Transportation Research is performing a most useful service in laying the groundwork for a considered approach to this problem as discussed by this group of papers and reports.

Discussion

Robert Snowber (Parsons, Brinckerhoff, Boston, Mass.). — I think Dr. Cline's point about the barriers created by freeways has interesting implications, one of them being that thought should be given in planning not to create new barriers but to parallel existing barriers. These barriers (such as railroads, items of topography, stream beds) are the barriers that have created the present road. If we could give more thought not to create new barriers but to utilize the existing barriers, we would not be creating any new segmentation.

I wonder if anybody in the audience has any experience or given a thought to a highway created not to create new barriers?

Cline. —There is little I can say about that except to agree. I do not know of any specific instances in which already established rights-of-way have been used to maintain the integrity of the community. What I suggest is that these alternatives ought to be more seriously considered by planners now. This is important because what you are planning may be dangerous and lethal to the surrounding community. Where and how you pick the particular routes is really your problem, to evaluate and recognize the requirements of the community and maintain its integrity.

M. L. Manheim (Department of Civil Engineering, MIT; Joint Center for Urban Study for MIT and Harvard). —Historically there seems to be a continuing trend to quantify as many variables as possible. For instance, economics and finance departments have been concerned with values of time as a particular example, trying to associate dollar values to time. Also, you have mentioned social consequences.

I do not think anyone will argue these are quantifiable. The kind of thing you are talking about is not measurable by numbers of parks, schools, and not even by juvenile delinquency rates. Therefore, as we expand the scope of our problems we are including consequences that are not commensurate to one another but are also not even quantifiable. Perhaps the issues which we have been historically concerned with, such as the value of time, become very much less important. We need to look now to ways to make decisions which we cannot put into single measure, such as dollars.

Graham (Boston Area Transportation Study). —Dr. Cline pointed out we have to be more careful about knowing more about existing conditions of certain areas. However, Mr. Colwell says we have to be conscious of all implications of social change, consumer preferences and so on. It seems that there is a gap here.

I would like to ask Dr. Cline how he feels the sociologists can help us to project social change in these neighborhoods so that transportation people can anticipate the needs in the future rather than what exists today?

Cline. --I am not sure I have either the formula or the answer. Maybe I can answer the question by restating a point in my paper: that methods for analyzing social structure are available. For those who are engineers, this is not a research problem, this is an engineering problem. I do not think we have to spend any time or money on how to study social structures. I am certain the materials and techniques are available. The statistics change; all forms of factors and variables in the social science literature (such as in economics and social psychology) are available as well.

I am not sure it is appropriate to say more than that it could be done. Maybe to get down to what Mr. Manheim said, we are really dealing with apples and bananas and we can translate geographic and demographic into one unit but not social and psychological into a comparable unit.

Economic and demographic variables in a sense can be evaluated as money. A transport route, a freeway, can be appraised on cost. The social and psychological values are not appreciated in this way. Maybe what we ought to consider is establishment of a different set of ultimate units to compare these apples and bananas into something that is comparable.

I think Professor Davis suggested the value systems of the community. If we decide to use as the unit of analysis of planning to be the value unit of the community and decide the contribution of the economic and demographic and the social and psychological into these terms, the value systems, then they become comparable. We have to decide before we start to build what values we want to build into our community, what values are there that we want to maintain, what values we want to destroy.

Joseph D. George (Metropolitan Toronto Roads Department, Chief Design Engineer). — I do not like to appear ungrateful but I grouped the papers in two parts, three into one group and Mr. Colwell's. It seems to me that we have a tendency to be impractical. Are we getting soft in a very hard world? When you consider the basic factors that affect design and layout of expressways, roads, and so on, you are always up against cost.

All these factors are certainly worth consideration but we should not have a tendency to make molehills into mountains because we will end up gilt-edging all these roads. We are losing the concept of value. How much are we going to spend on these roads and where are we going to stop? A road after all has certain basic functions, as Mr. Davis pointed out. We have to be frank, otherwise we would be wasting our efforts and some of these points brought up are fine as long as they are viewed in proper perspective.

Bernard A. Lefeve (New York State Department of Public Works, Deputy Chief Engineer). —These considerations may very well spell destruction of highways in cities. Let me give an example in New York. You have a situation where people will not allow an incinerator to be built within a short distance of homes. On the other hand, when an incinerator or sewage plant is built, you find homes creep up against them. How serious is this nuisance value? I think we should consider that highways should be built in cities. They should look impressive. They should not look like railroad rights-of-way, things like that have had a deteriorating effect on land use and property values.

I might add we had a recent experience in New York City where a very important crosstown expressway was stopped by these considerations and it will have a serious effect on the future of that area. It will remain a rundown area. If the highway had been built it would have been a revitalization of the area.

I think we should consider the social effects and we should plan for the other effects as well, to make not just a highway plan but a whole redevelopment plan. This will be a better scheme for highway planning.

Cline. —The visual aspect of our environment is not superfluous gilt-edging of our lives. This is of fundamental psychological importance to us.

I do not think a city like Washington was designed and built entirely with cost in mind. I do not think we can build any environment in terms of only money value, there are social and psychological values.

Herbert Mohring (University of Minnesota). —There is one point that perplexes me. If I understand correctly, the material presented by both Mr. Lynch and Mr. Cline has a certain static quality. Nevertheless, we all know these neighborhoods change. Even the visual points in the community change in time. What we build today is likely to remain built for another generation, at least.

Is there any way of relating the dynamic qualities and the visual and esthetic qualities to the years ahead rather than just traffic conditions today?

Zwick.—The gentleman from Boston indicated he thought there was a gap between these papers. I think more than a gap; I think a disagreement, very specifically.

With regard to how we are going to get ahead on these values I would take the position the primary way we do it in our society is in the marketplace. We adjust that through government action. I would like to have this on a more objective form. Some of these things cannot be stated in quantitative terms.

I do think there is this basic situation of the current situation versus the future: how much do you want to perpetuate the current pattern.

I am really not an economist but an unemployed whip maker. It turns out that Zwick is the German word which if you turned it back it does mean whip maker. I suppose if we had prevented all this social change I might still be in Germany rather than sitting in California and driving to Santa Monica every day.

I personally would like to place a lot more emphasis on letting the marketplace decide these things, modified by a number of other considerations.

Paul Oppermann (Northeastern Illinois Metropolitan Area Planning Commission, Chicago).—I do not know whether I am more encouraged or discouraged. It seems to me we have been moving in one direction this morning and I for one welcome it and commend it highly. It is extremely useful and suggestive.

I was thinking a moment ago about Professor Davis' summary where he spoke of the fact that we have a very wide spectrum to work. In this spectrum the new additions are extraordinarily useful. It is just beginning. But in the team sense we are talking about operations, again in interdisciplinary or multi-approach, the relationship of plan to operations. Nowhere have we become operational with very many skills, or have some of the people you have named already become useful to us for practical purposes? But the practical thing in a plural society which we have is to employ these various skills in proper combinations in the teams.

I suggest, and I believe it is quite demonstrable, we have not begun to be operational in the team sense. Our teams are heavily weighted by people concerned with your market, the functional scientific approach, with its qualifiable matter and not with the values judgment, some of which are wholly unfamiliar and are not agreeable to the masters of these teams.

I would hope that we could begin to talk in what I think are very practical terms of how we are going to have these members, disciplines, or the values that are not present, how we are going to have them present in the competition among these skills to have their say and have it effectively.

We go again to the role of the citizen. Unless the citizen understands these concepts—which are very sophisticated concepts—unless they are made available to leaders, they cannot be effective.

I suggest that we devote some of our time at these sessions to setting up concrete concepts of how to develop these teams in balance and how through our operational agencies we can begin to test these judgments and values which are not yet in the team picture.

Mohring.—I think Mr. Cline has given up much too easily on the possibility of translating social psychological data into dollars. I was wondering if he had given any thought on how one might set up tests necessary to achieve such a thing?

Zwick.—In my paper I argued one of the things we should be doing is sponsoring experiments. If you like, let people choose, see what preferences really are. It seems to me that is one way to get at it. The other way is to discuss it.

Colwell.—Also, there are some tools now borrowed from economics that attempt to express data that cannot be expressed in terms of numerical theories yes or no.

Cline.—I think there is a great variety available now for translating social psychological data to economic data. At the same time I want to suggest that significant changes in the social structure can be translated into generation of might, and might, I am sure, is something you can identify in terms of economic terms. I do not think it is difficult to say what society loses or gains from economic changes within a particular community. This is not a major problem now to crank into the kind of decision processes available to us now.

I want to suggest still further that if we define the marketplace as defined by Mr. Zwick for us, we define it as the final process by which the decision is to be made. What we are doing if we let the normal give and take of economics occur is to allow for elimination of large sources of significant data.

Clifford D. Rassweiler (Johns-Manville Corporation). --Just one quick point about the marketplace and the decisions of the marketplace. The decisions are not made on the basis of cost alone, that in the decisions of the marketplace these intangibles are terribly important as to what is to be done and not done.

Robert B. Mitchell (University of Pennsylvania, Philadelphia). —There has not been a paper here or analysis I have seen anywhere of the values that are created by major transportation facilities in other locations from which they remove traffic. I was on a street called Germantown Avenue, one of the most ancient streets in this country. It is so old that George Washington marched down it to battle once. If you tore down Germantown Avenue you would have to knock down 75 percent of the old houses in that city. The preservation of this street ought to be considered. To get rid of heavy traffic without destroying that can be considered and included in our work.

Cline. --Just one point about the functions of special interests. One of the functions is to clarify their particular interests, so that these can be discussed openly and then proposals evaluated in common discussion. This is what we are trying to do. One can certainly evaluate whether a highway is coherently structured or fragmented. You can certainly evaluate whether a highway is meaningful or meaningless. It can be fairly clearly identified.

I should think you would be in general agreement with the points we are trying to get over and therefore are discussable. One means is to clarify the objective and the other one is to develop a language in which we can communicate these problems.

Carroll. —After a week of sessions I concur in the language problem. If somehow we could just get words on a common basis.

Lefeve. —I think we have this language problem. I think in listening to all these words that they are strange to engineers.

I think we have a problem of finding a yardstick to measure these things. I do not think there is disagreement as to value, it is how to measure them. You have got to be within the economic range of the facility you are building.

These things you talk about are going to have to be done soon and translated from these very nice words. Put names on these values you talk about so we can measure them and evaluate them. Use terms we can understand—tons, feet, etc.

Introductory Remarks to the Second Session

DONALD C. WAGNER, Managing Director of Philadelphia, Philadelphia, Pennsylvania

•AS THE ONLY administrative official assigned on this topic I feel I have a special concern about community values and about what effect transportation will have on them. We are obliged to weigh and compare alternative means to meet transportation needs, making use of all the modes that prove practical and feasible.

My concern for community values is too real and goes too deep to accept the notion that a valid transportation plan will somehow evolve simply from a summation of the desires of the five million citizens in the Philadelphia area. The problem and the times call for leadership and skill in providing the transportation facilities that will help preserve and obtain those community values which we seek.

Uncontrolled urban sprawl preserves few if any community values. On the other hand, statesmanlike efforts on the part of civic and business leadership can make dreams of a vital and useful, functional, helpful city come true.

An example of a dream that will come true is a report just released by the Philadelphia Public Planning Commission. It builds on the already vast community values in Central City and by full use of all modes of transport and all other available resources it shows what can be achieved within the approximately four square miles of the center by inner expressway loop, new stations and new vistas, bus lines and well-placed parking facilities, promenades for shopping at street levels and one level above street level as well. All this adds up to an exciting future for downtown Philadelphia.

That is only one of many values. Philadelphians want this community value preserved. The report itself states in the introduction that the well-being of Central City is basic to the well-being of the entire region. The Central City must always remain doing business and also provide those special things that give richness to life, and for those great cultural activities which set the tone.

Among the other community values are the amenities of urban living—libraries, schools, institutions of higher learning, health centers, hospitals, and neighborhood shopping. All of this adds up to a sense of belonging. These all play a vital part in making urban living pleasant.

Effects of Density on Urban Transportation Requirements

HERBERT S. LEVINSON and F. HOUSTON WYNN, Wilbur Smith and Associates

•THE SPATIAL distribution and concentration of people within the urban complex is an important determinant of urban shape, structure, and transportation requirements. Population density influences both travel patterns and land use configurations. Traditionally, density has been closely related to transportation systems; even today, the impacts and intereffects are apparent.

The purpose of this paper is to analyze some of the more pertinent interrelationships between population density and urban transportation requirements, both on a city-to-city basis, and also within given cities. The paper traces and extends the many density-travel analyses developed to date. Analyses are made of regional and historical effects on population density, distribution patterns of urban density, and density implications on total person and vehicular trip generation, car ownership, travel mode, transit patronage, and freeway impacts.

The timeliness of such a discussion is evident. The concept of density best characterizes the change in urban structure that has taken place in the last several decades: "sprawl," "suburbia," "spread-city," "decentralization," are all consequences, or derivatives, of shifts in urban densities. Thus, density is a basic parameter that should be given careful consideration in urban transportation analyses.

DENSITY AND URBAN STRUCTURE

Density, like population, identifies specific cities; it is perhaps the clearest measure of how suburbia differs from the central city; it represents the most perceptible contrast between urban areas throughout the world.

A few key statistics emphasize this point. Table 1 shows the Nation's "urbanized-area" population increased 38 percent between 1950 and 1960. Simultaneously, the land devoted to urbanized areas doubled. Although over-all densities in urbanized areas decreased approximately 31 percent, the decreases approximated 31 percent in central cities and 19 percent in fringes.

Because the 1960 data include 213 urbanized areas, as compared with 157 in 1950, these figures are not wholly comparable. Accordingly, the data were adjusted to include only the 157 urbanized areas defined in 1950 (Table 2). In these areas, urbanized area population increased 30 percent and land area increased 80 percent. Over-all urbanized area densities decreased 28 percent—fron 5,408 to 3,894 people per square mile. In 1960, density of "fringe" or "suburban" areas approximated 2,600 persons per square mile.

The "density gradient" concept clearly explains the lower density of suburbia (1-5)—employment and residential densities decrease inversely with distance from downtown. The decrease, though rapid in the first, second, and third intervals or "rings" outward from the central business district (CBD), tends to become more gradual in subsequent concentric zones. In suburbia, density tends to decrease at much lower rates than in the central city.

Although differences exist between suburbia and the central city, differences on a global basis between North American and European cities are even more striking (Table 3). The six leading U. S. and Canadian cities have an average density of about 14,000 people per square mile (19,000 when Los Angeles is excluded) compared with a density of about 23,000 people per square mile in eleven leading worldwide cities (29,000 when the Greater London conurbation is excluded). The greatest densities, as would be anticipated, are found in Asiatic and Latin American cities.

Paper sponsored by Special Committee on Urban Transportation Research.

TABLE 1

CHANGES IN URBANIZED AREAS 1950-1960[a]

Year	Central Cities (No.)	Urbanized Areas (No.)	Population			Land Area (sq mi)			Density (persons/sq mi)		
			Central City	Fringe	Urbanized Area	Central City	Fringe	Urbanized Area	Central City	Fringe	Urbanized Area
1950	172	257	48,377,240	20,874,994	69,252,236	6,213.2	6,591.4	12,804.6	7,786	31,187	5,408
1960	254	213	57,795,132	37,873,355	95,848,489	10,837.7	14,706.6	25,544.3	5,349	2,575	3,752
% Change	--	--	19.4	81.4	38.4	74.4	122.3	99.5	-31.3	-19.2	-30.6

[a]Source: U.S. Bureau of Census.

TABLE 2

CHANGES IN URBANIZED AREAS 1950-1960[a]

Year	Central Cities (No.)	Urbanized Areas (No.)	Population			Land Area (sq mi)			Density (persons/sq mi)		
			Central City	Fringe	Urbanized Area	Central City	Fringe	Urbanized Area	Central City	Fringe	Urbanized Area
1950	172	157	48,377,240	20,874,994	69,252,234	6,213.2	6,591.4	12,804.6	7,786	3,187	5,408
1960	172	157	53,477,361	36,506,549	89,983,910	9,169.3	13,940.7	23,110.0	5,832	2,619	3,894
% Change	--	--	10.5	74.9	29.9	47.6	115.0	80.5	-25.1	-17.8	-28.0

[a]Source: U.S. Bureau of Census.

Many of the large American cities have located in areas that are far less restrictive and confining, topographically. This, in part, explains the greater concentrations in European and Asiatic cities. Age of city, and economy of the city's residents are obviously key factors. It should, of course, be realized that there is no consistent definition of central city limits, and that this variability can influence density values and comparisons.

Regional Variations

To appraise the general effects of region, city size, and age, on population density, scatter diagrams were drawn for selected years between 1920 and 1960. These diagrams (Fig. 1) show the historical population-density relationships for U. S. cities.

The scatter diagrams indicate a general tendency for central city density to increase with city size; larger cities are generally more dense. The relationships, however, are not totally consistent and there are many variations: topographic limitations, for example, tend to encourage high densities (e.g., Pennsylvania "valley" towns); delineation of city limits with respect to population concentration is also significant (e.g., Houston); proximity of incorporated areas which preclude ready annexation to serve new growth are also reflected in the densities (e.g., Boston).

Equally significant are the "regional" population-density characteristics for New England-Middle Atlantic cities, for midwestern cities, and for new, rapidly expanding southwestern U. S. cities. For any given level of population, densities are highest in eastern cities and lowest in the southwest; new cities-- those developing after 1920-- generally tend toward densities of about 5,000 people per square mile.

Population-density scatter diagrams for Canadian and other world cities are shown in Figure 2. In is again apparent that city size, topography, and regional economy influence density. Quebec cities, for example, are more dense than Alberta cities, with Ontario cities intermediate; the highest densities (averaging over 70,000 people per square mile) are found in Calcutta and Bombay, India.

The generalized relationships between population and density in U. S., Canadian, and European cities are shown in Figure 3. These curves show the "expected" behavioral patterns for various types of cities; they denote density "norms" for cities of various population groupings. The patterns for U. S. cities denote the averages over the last forty years inasmuch as there has been comparatively little change in specific patterns over this period. Based on this figure, expected density norms for cities

TABLE 3

POPULATION AND DENSITY OF MAJOR CITIES[a]

World Area	Central City	Year	Population	Area (sq mi)	Density (persons/ sq mi)
U.S. and Canada	New York City	1960	7,781,984	315	24,697
	Chicago	1960	3,550,404	224	15,836
	Los Angeles	1960	2,479,015	455	5,451
	Philadelphia	1960	2,002,512	127	15,743
	Detroit	1960	1,670,144	140	11,964
	Montreal	1956	1,109,439	47	23,525
	Avg.		3,098,916	218	14,215
	Avg. excluding Los Angeles		3,222,966	181	18,891
Other	Tokyo	1960	9,124,217	207	44,078
	Greater London	1960	8,210,000	722	11,377
	Shanghai[b]	1953	6,204,000	345	17,982
	Osaka	1960	5,158,010	123	41,935
	Berlin	1960	4,244,600	344	12,339
	Buenos Aires[b]	1955	3,575,000	74	48,310
	London	1948	3,339,000	117	28,538
	Bombay[b]	1960	3,000,000	30	100,000
	Rio de Janeiro[b]	1955	2,900,000	60	48,333
	Calcutta	1961	2,926,498	39	74,200
	Paris[b]	1955	2,850,000	147	19,388
	Avg.		4,684,666	200	23,338
	Avg. excluding Greater London conurbation		4,332,132	149	29,075

[a]Compiled from U.S. and world census data, from "World Resource Statistics" by J. Weaver and F. Lukerman, Briggs Publishing Co., Minneapolis; and from "The World's Metropolitan Areas," University of California Press (1959). Data shown only for cities where available.

[b]Some estimates were made pertaining to coincidence of population and area values.

with a million people are given in Table 4. It may be seen that the curve for European cities closely parallels that for New England and Middle Atlantic cities (Fig. 3). Similarly, the curve for German cities tends to parallel that for Midwest U. S. cities. (The lower densities in German cities may somewhat reflect wartime devastation.)

The preceding analysis indicates that population and density are interchangeable only within broad limits. Thus population, or "city size" per se, does not fully reflect city structure, except in like geographic areas.

City Age

"Urban maturity" also appears to influence city composition. When the year that central cities first reached 350,000 people is plotted against 1950-1960 central city densities (Fig. 4), there is a general consistency. Cities that reached 350,000 between 1830 and 1890 (before the advent of the electric street railway) generally had the highest densities, whereas, cities that reached 350,000 between 1930 and 1960 (the automobile era) generally had the lowest densities. Thus, central city density also depends on the mode of intra-urban transportation prevailing at the time the central city was

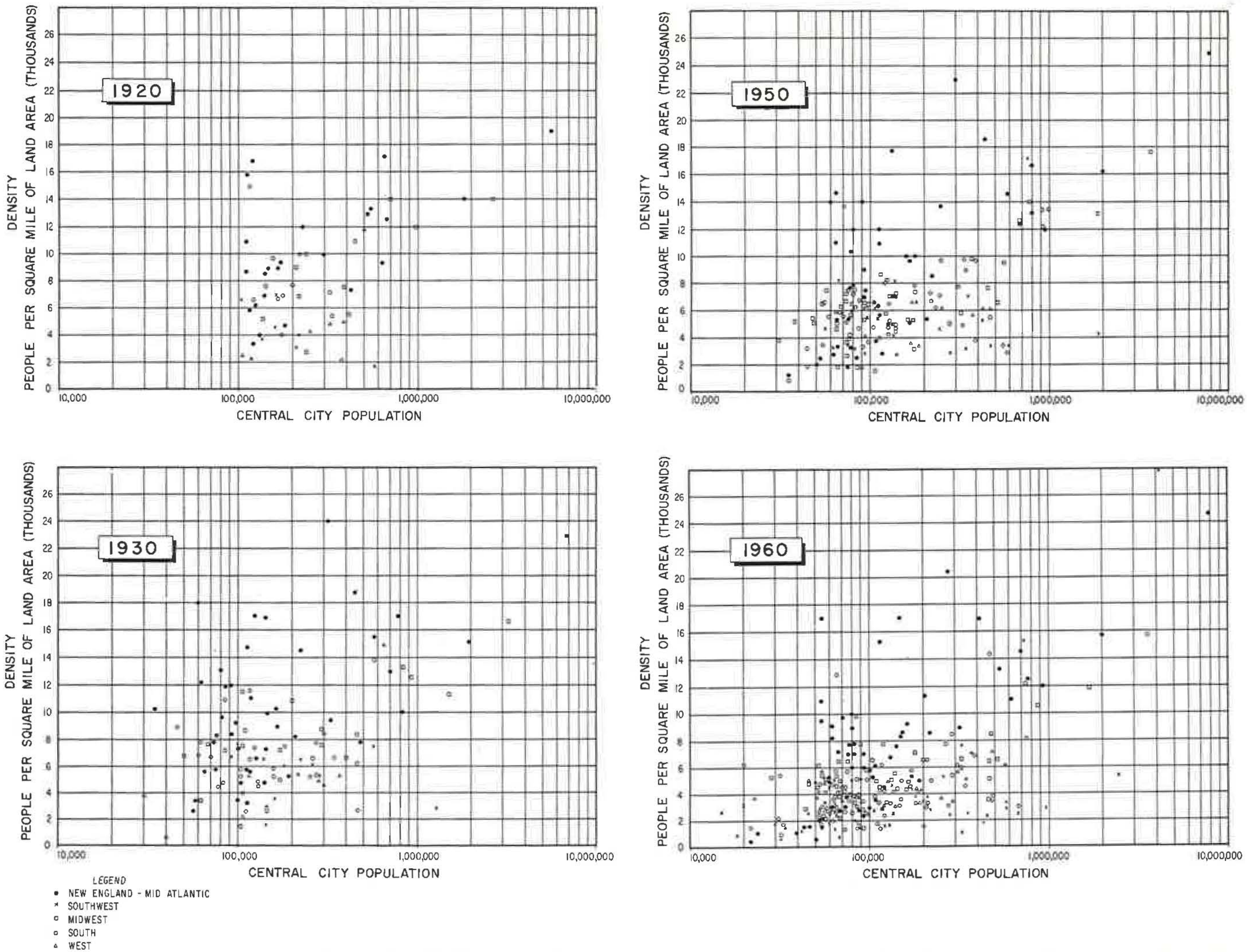

Figure 1. Population-density relationships, U. S. cities.

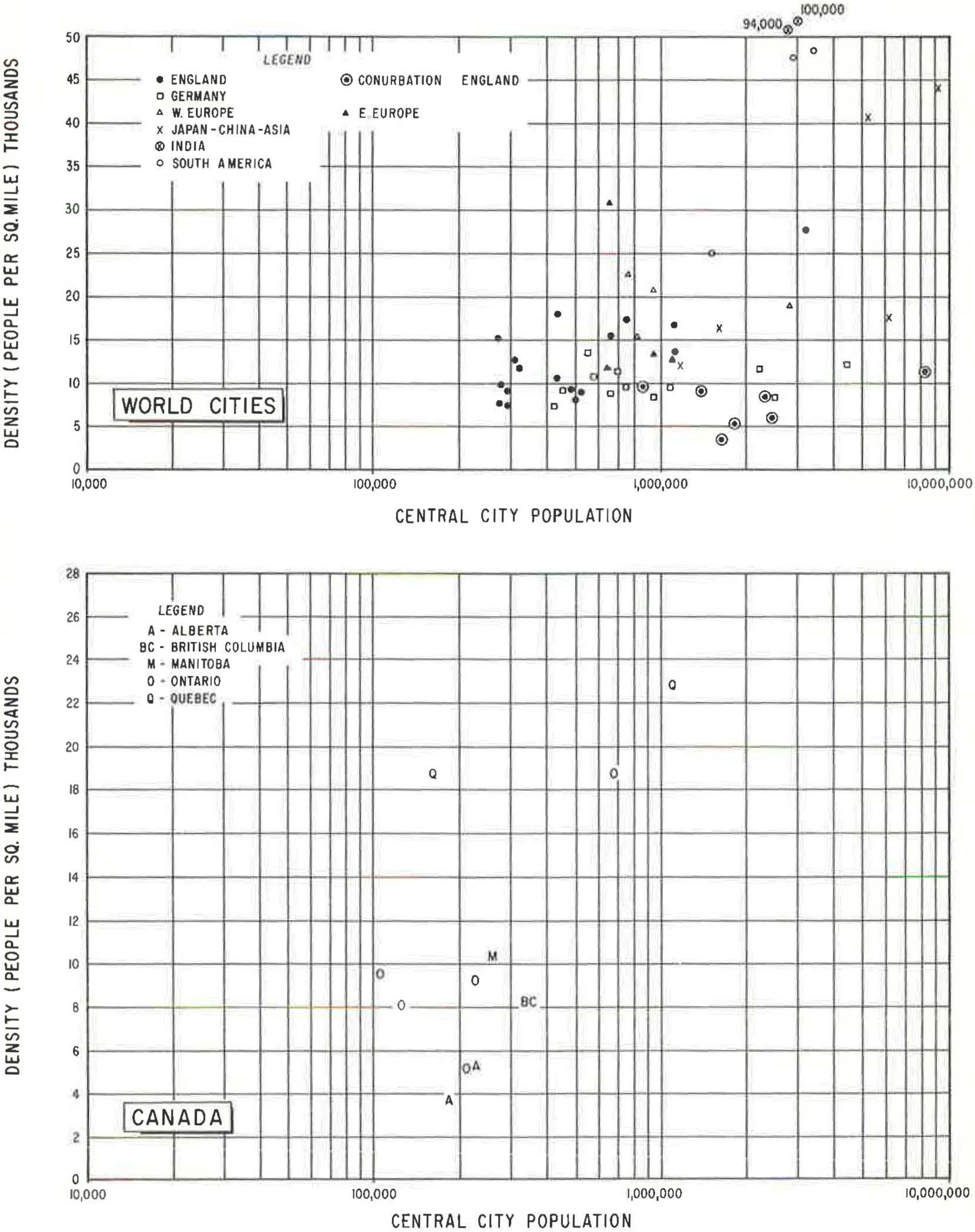

Figure 2. Population-density relationships, Canadian and other world cities.

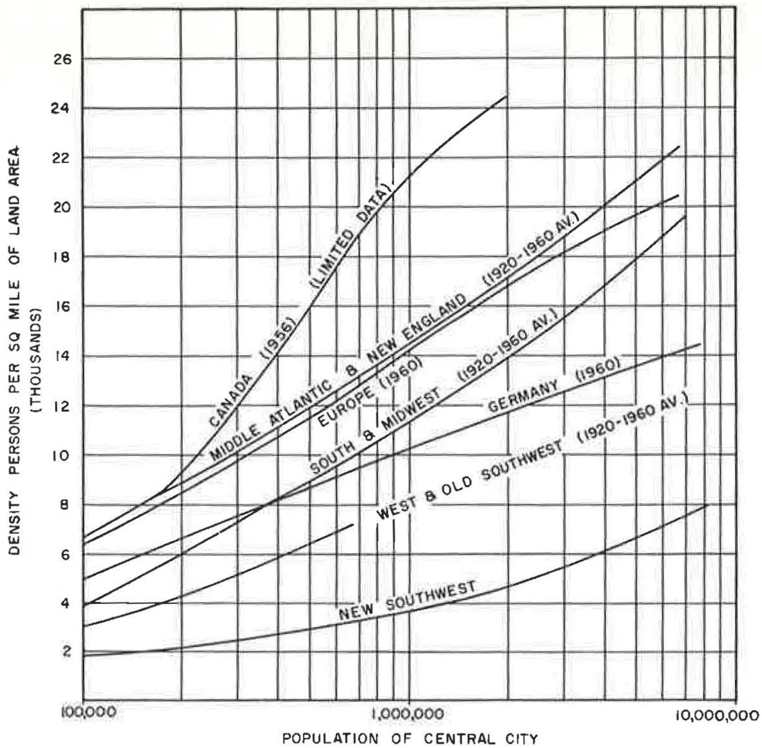

Figure 3. Population density, U. S. and other world cities.

built, with cities built around pedestrian travel often being the most dense. City age, therefore, as well as population is significant in determining densities; the year that central cities reached given levels of population is closely related to their present concentrations.

Internal Distribution of Densities

Investigations were made of the distribution of population within an urban area according to various density levels. Relationships between average over-all densities and how densities are distributed throughout the urban area could provide predictive bases.

Recent comprehensive metropolitan area transportation studies provide a wealth of background information on the internal distribution patterns within the urban area. The subsequent pilot analyses have, therefore, been based on data set forth in the Chicago, Chattanooga, and Pittsburgh area transportation studies. In each case, density data are for the entire survey area; the populations included are given in Table 5.

The density distribution patterns shown in Figures 5 and 6 (and detailed in Table 6) denote the relative proportions of people in Chattanooga, Chicago, and Pittsburgh living at various net residential densities.

TABLE 4

EXPECTED DENSITY NORMS FOR CITIES WITH A MILLION PEOPLE

Area	People per Square Mile
Canada	21,000 [a]
U. S. Middle Atlantic U. S. New England Europe	14,000-15,000
U. S. Midwest & South	11,000
Germany	10,000
U. S. West & Old Southwest	8,000 [a]
U. S. New Southwest	4,000

[a] Limited data.

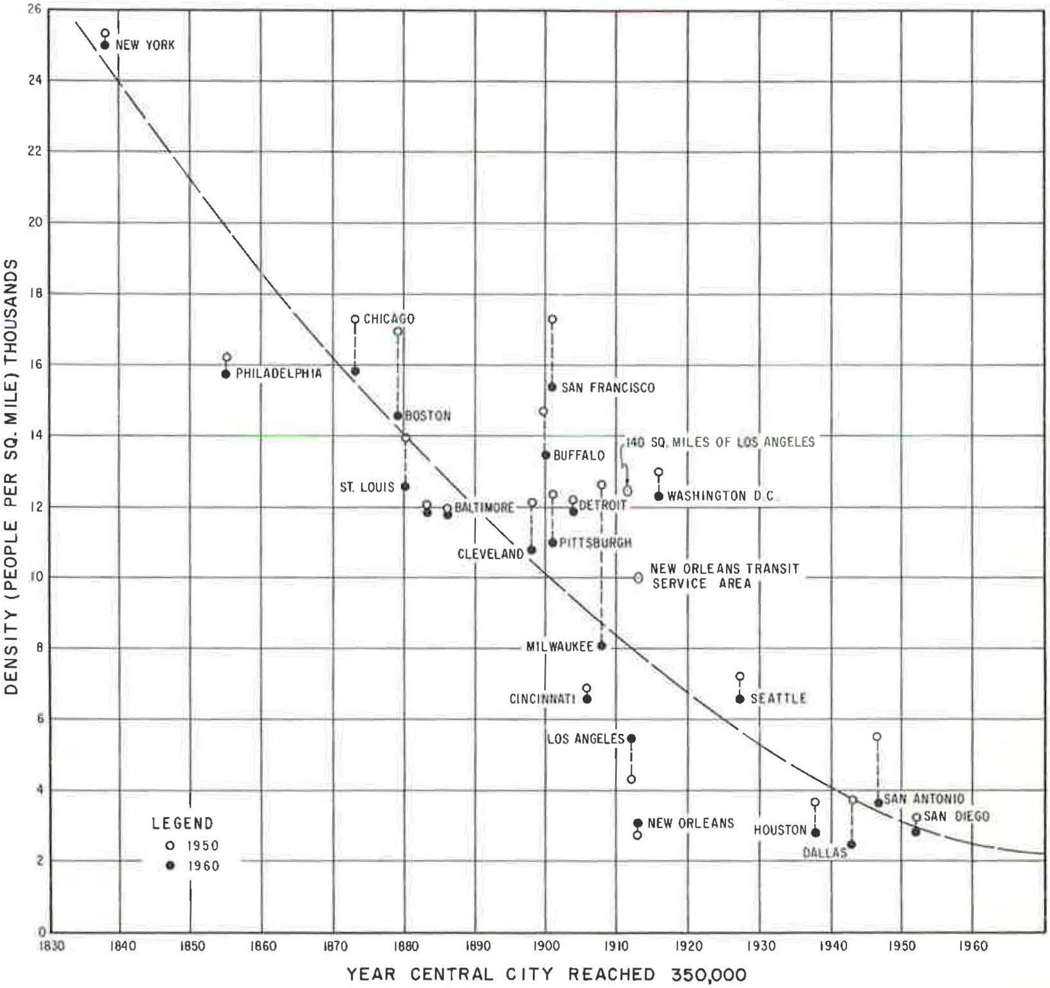

Figure 4. Effect of city age on population density.

Figure 5 shows the average densities for various levels of population. For example, in Chattanooga the average density for the densest 20 percent of the population is 50 persons per acre; the average density for the densest 50 percent of the population is 32 persons per acre; the over-all average net residential density approximates 12 persons per acre.

Figure 6 and Table 6 present cumulative frequency distributions. In Chattanooga, for example, approximately 20 percent of the population live at densities of 80 persons per acre or more; one-half the population lives at densities of 16 people per acre or more.

The curves for Chicago show that each component of the population lives at higher over-all densities than is the case in the other two cities. As would be expected, the curves for Chattanooga are lowest, and those for Pittsburgh are intermediate. This is again consistent with the size and age of the cities.

TABLE 5

SURVEY AREA POPULATIONS

Area	Population	Net Residential Density (persons per acre)
Chattanooga [a]	210,312	11.6
Chicago	5,169,663	44.7
Pittsburgh	1,472,099	28.4

[a] Tennessee portion only.

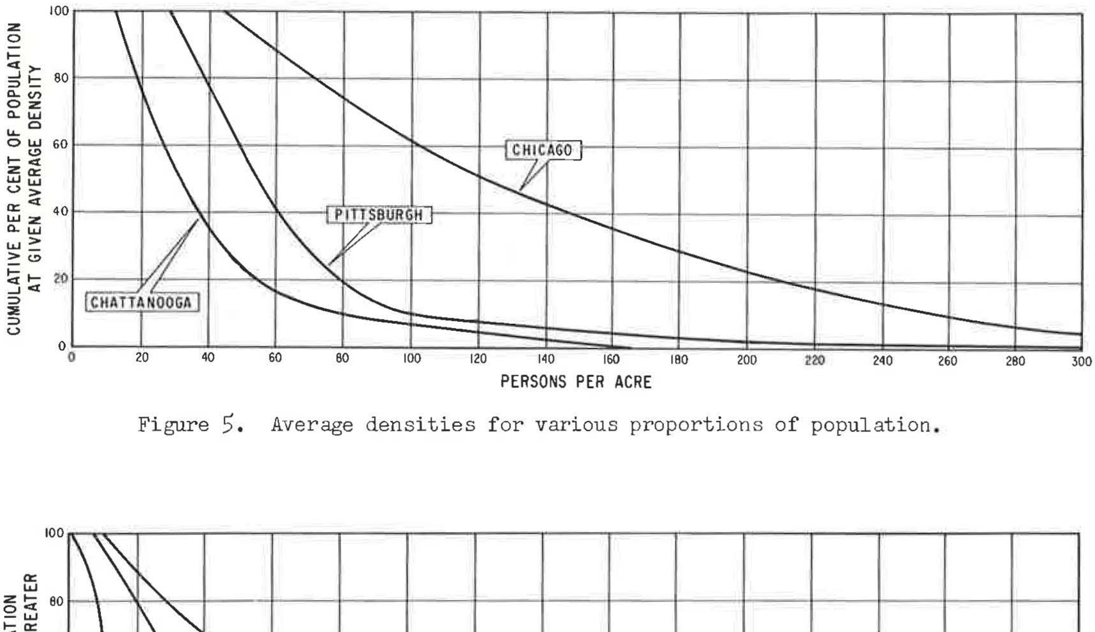

Figure 5. Average densities for various proportions of population.

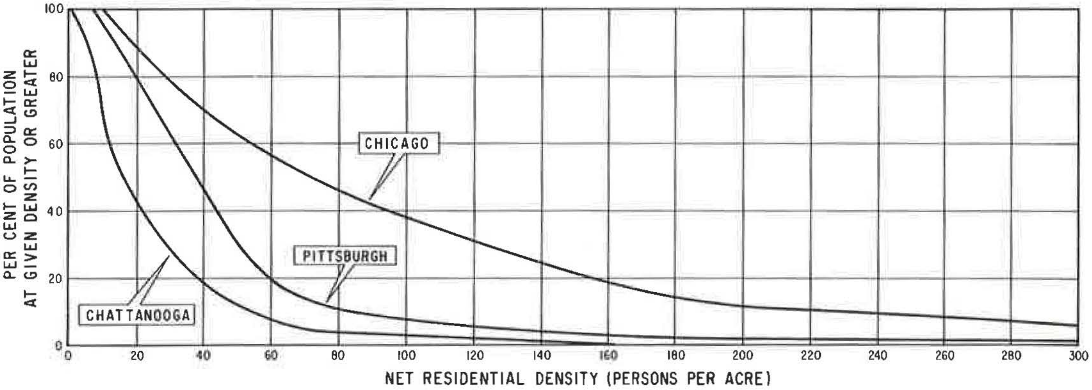

Figure 6. Cumulative distribution of population according to density, three urban areas.

TABLE 6

DISTRIBUTION OF POPULATION AND DENSITY IN THREE URBAN AREAS[a]

Net Residential Density (persons per acre)	Chattanooga		Chicago		Pittsburgh	
	Percent of Pop.	Cum. Percent	Percent of Pop.	Cum. Percent	Percent of Pop.	Cum. Percent
Over 200	0.0	0.0	12.9	12.9	0.2	0.2
150-200	0.5	0.5	11.1	24.0	0.3	0.5
125-150	0.0	0.5	3.1	27.1	4.3	4.8
100-125	0.0	0.5	10.5	37.6	0.0	4.8
75-100	4.5	5.0	10.9	48.5	6.8	11.6
50-75	4.5	9.5	10.3	58.8	19.1	30.7
40-50	7.0	16.5	10.0	68.8	20.3	51.0
30-40	13.5	30.0	13.3	82.1	11.5	62.5
20-30	12.7	42.7	4.2	86.3	11.5	74.0
10-20	27.0	69.7	13.5	99.8	23.7	97.7
5-10	22.9	92.6	0.2	100.0	2.3	100.0
0-5	7.4	100.0	0.0	100.0	0.0	100.0
Total population	210,832		5,169,663		1,472,099	
Net residential density	11.6		44.7		28.4	

[a]Source: origin-destination studies in each area.

TABLE 7

POPULATION AND AREA IN THREE URBAN AREAS[a]

Cumulative Percent of Population	Cumulative Percent of Residential Area		
	Chattanooga 1960	Chicago 1956	Pittsburgh 1962
0	-	-	-
10	1.5	1.7	3.0
20	4.4	4.3	7.6
30	7.8	7.3	12.8
40	12.3	12.0	19.0
50	18.3	17.3	26.0
60	27.3	25.0	34.3
70	38.4	35.0	45.0
80	51.6	48.9	59.0
90	67.4	68.4	75.3
100	100.0	100.0	100.0
Total population	210,382	5,169,663	1,472,099
Total residential area	18,187.0	115,574.8	51,794.9
New residential density (persons per acre)	11.6	44.7	28.4

[a] Source: origin-destination studies in each area.

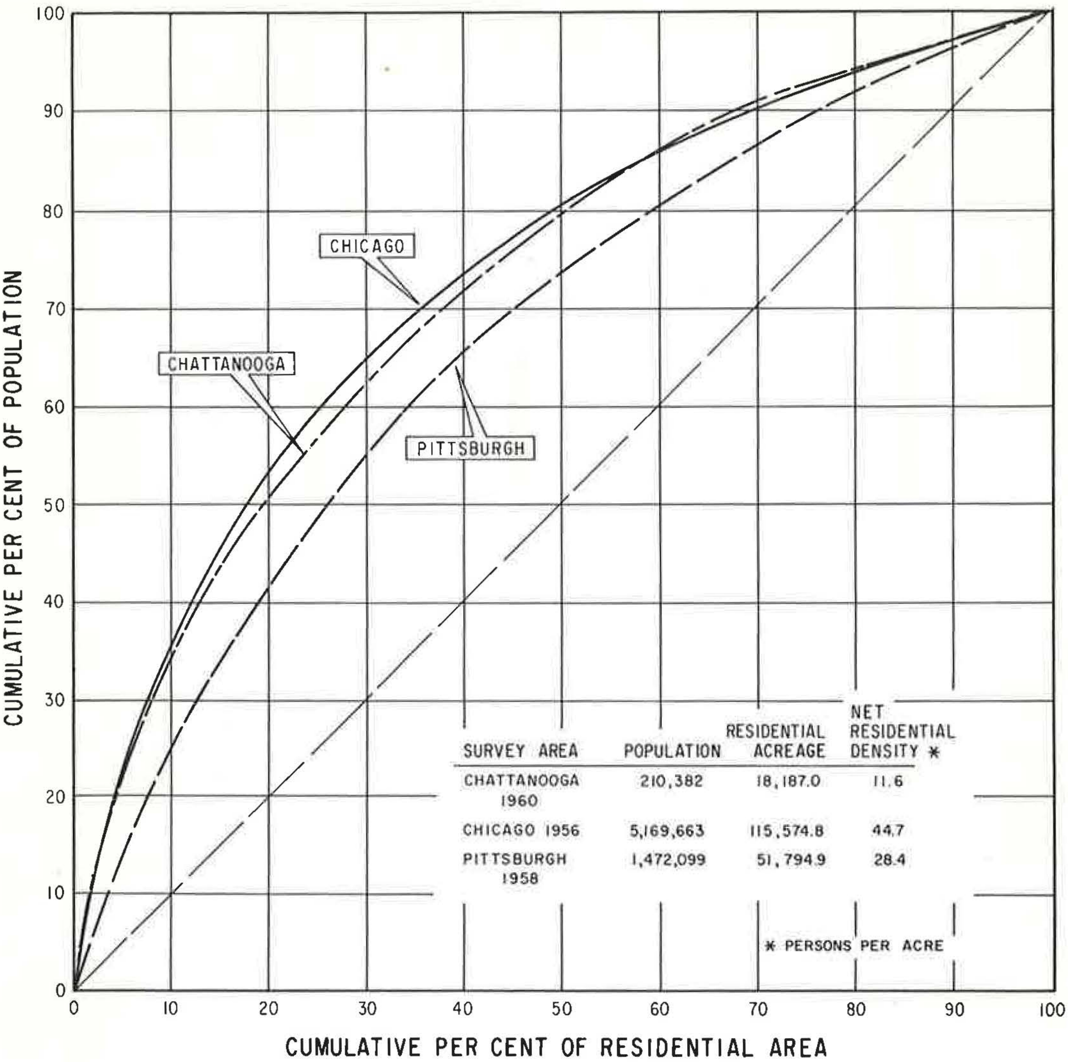

Figure 7. Distribution of population and land, three urban areas.

The distribution of population and land in the three urban areas also exhibits certain consistencies. As shown in Figure 7 and Table 7, there are similarities between the relative distribution of people and land. This is particularly true for the Chattanooga and Chicago areas despite their difference in size.

Given the average density of an area, the similarity in shape of these curves permits estimation of the proportions of people living at densities of 1, 2, 3, 4, . . . n times the average density. Accordingly, a further analysis was undertaken within the three urban areas in which the absolute densities were standardized by expressing them as percentages of the average density in each urban area. Results are shown in Figure 8 and Table 8.

There is a general similarity in the proportions of people in each urban area living at the same relative density. The closeness between the Chattanooga and Chicago results suggests that the curves could possibly be used for predictive purposes. Obviously, verification in other cities is desirable.

Within the central city itself, there are often pronounced differences in the density

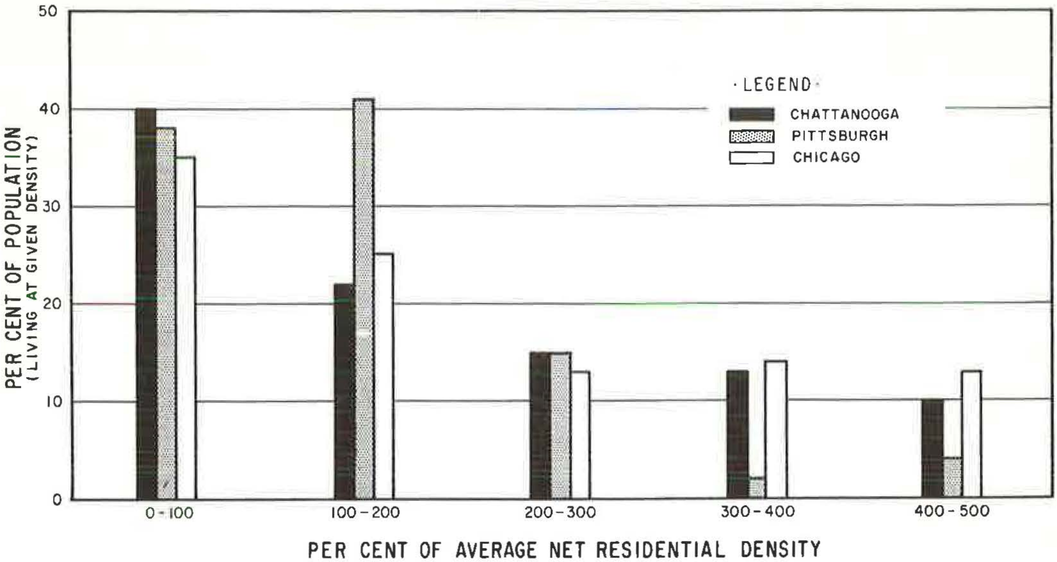

Figure 8. Distribution patterns of residential densities.

of the entire population and that of a proportion. In Los Angeles, for example, the 2.5 million residents have an average over-all (gross) density of approximately 5,500 people per mile. However, nearly 1.8 million people (72 percent of the population) live in 140 square miles at an over-all density of nearly 13,000 people per square mile (6). By way of comparison, a population of 1.8 million in Chicago had over-all densities of about 22,000 people per square mile in 1910, approximately 27,000 between 1920 and 1950, and about 23,000 in 1960 (7). Such comparisons of the "most dense" component of the central city are valuable for appraisal of public transportation needs.

TABLE 8

COMPARATIVE FREQUENCY OF RELATIVE DENSITIES IN THREE URBAN AREAS

Percent of Average Net Residential Density[a]	Chattanooga		Chicago		Pittsburgh	
	Percent of Pop.	Cum. Percent	Percent of Pop.	Cum. Percent	Percent of Pop.	Cum. Percent
Over 1,000	0.5	0.5	0.0	0.0	0.2	0.2
900-1,000	0.0	0.5	0.1	0.1	0.0	0.2
800-900	0.0	0.5	0.0	0.1	0.0	0.2
700-800	0.0	0.5	0.0	0.1	0.3	0.5
600-700	7.0	7.5	6.2	6.3	1.1	1.6
500-600	0.8	8.3	2.5	8.8	0.0	1.6
400-500	1.2	9.5	4.2	13.0	3.2	4.8
300-400	13.2	22.7	14.2	27.2	1.7	6.5
200-300	14.8	37.5	13.3	40.5	14.5	21.0
100-200	22.5	60.0	24.5	65.0	41.2	62.2
50-100	29.8	89.8	19.7	84.7	31.6	93.8
25-50	8.4	98.2	13.9	98.6	5.8	99.6
0-25	1.8	100.0	1.4	100.0	0.4	100.0

[a] Average density would be equal to 100 percent.

DENSITY AND URBAN TRAVEL

Comprehensive metropolitan area transportation studies have increasingly recognized the effects of density on urban travel. Mayer (8) points out that the tendency for highway-oriented development is to fill the interstices between high-density transit-oriented corridors. Bartholomew (9) cites the problem of providing public transportation in sparsely settled areas. More recently, the density aspect of urban structure

TABLE 9

EFFECTS OF DENSITY ON TOTAL TRIP GENERATION: ILLUSTRATIVE EXAMPLES

Study	Year	Eq. No.	Equation[a]	Coefficient of Correlation (r)
Between Several Cities:				
Future Highways and Urban Growth	1961	A	$Y_1 = 2.7 - 1.17\ x_1$	Hand fit
Some Aspects of Future Transportation in Urban Areas	1962	B	$Y_1 = 2.6 - 0.092\ x_6$	Hand fit
		C	$Y_1 = 2.6 - (0.092) \frac{x_1}{x_3} (10)^{-3}$	Hand fit
Within Cities:				
Detroit Area Transportation Study	1953	D	$Y_2' = 15.07 - 4.23 \log x_2$	-0.75
		E	$Y_2' = 1.87 + 4.26 \log x_4 - 1.60 \log x_2$	0.83
A Study of Factors Related to Urban Travel[b]	1957	F	$Y_2 = 7.22 - 0.013\ x_2$	0.72
		G	$Y_2 = 4.33 + 3.89\ x_3 - 0.005\ x_2 - 0.128\ x_4 - 0.012\ x_5$	0.84
		H	$Y_2 = 3.80 + 3.79\ x_3 - 0.0033\ x_2$	0.84
St. Louis Metropolitan Area Transportation Study	1959	I	$Y_6 = 0.261 - 0.017\ x_7$	Not cited
Chicago Area Transportation Study	1956	J	$Y_4 = 6.64 - 2.43 \log x_2$	-0.95
		K	$Y_5' = 4.32 - 1.90 \log x_2$	-0.96
		L	$Y_2 = 11.80 - 4.246 \log x_2$	-0.97
		M	$Y_3 = 7.34 - 3.29 \log x_2$	-0.96
Pittsburgh Area Transportation Study	1962	N	$Y_2 = 9.62 - 4.19 \log x_2$	-0.88
		O	$Y_3 = 5.55 - 2.64 \log x_2$	-0.91
		P	$Y_4 = 5.02 - 2.17 \log x_2$	-0.87
		Q	$Y_5 = 3.35 - 1.35 \log x_2$	-0.90

[a] Dependent Variables:
- Y_1 Total internal person-trips per capita
- Y_2 Person-trips per family
- Y_2' Person-trips per dwelling place
- Y_3 Auto-trips per family
- Y_4 Person-destinations per dwelling place
- Y_5 Auto-destinations per dwelling place
- Y_5' Vehicle-destinations per dwelling place
- Y_6 School trips per person

Independent Variables:
- x_1 Gross urbanized-area density
- x_2 Dwelling places per residential acre
- x_3 Autos per dwelling unit
- x_4 Distance from CBD
- x_5 Family income
- x_6 (Households per car) X urbanized area pop. density X 10^{-3}
- x_7 Thousands of people per square mile

[b] Public Roads, 29: No. 7 (April 1957), based on Washington, D.C.

TABLE 10

DISTRIBUTION OF CAR OWNERSHIP 1961 IN 115 U. S. COUNTIES[a]

People per Car	Number of Counties	Percent of Total	Typical Counties Included
Less than 2.0	0	0.0	
2.1 - 2.5	18	15.7	Los Angeles, Dade, Fort Lauderdale
2.6 - 3.0	61	53.0	D. C., Oakland, Cuyahoga
3.1 - 3.5	23	20.0	Cook, Allegheny
3.6 - 4.0	7	6.1	St. Louis, Baltimore, Orleans
4.1 - 4.5	3	2.6	Philadelphia, Suffolk (Boston), Queens
4.6 - 5.0	0	0.0	
5.1 - 5.6	0	0.0	
5.6 - 6.0	1	0.9	Kings (Brooklyn)
Over 6.0	2	1.7	New York (Manhattan), Bronx
Total	115	100.0	

[a]Source: Automobile Manufacturers Association, "Automobile Facts and Figures," 1962 ed.

was carefully interwoven throughout "Future Highways and Urban Growth" (10). A lucid account of the forces underlying urban transportation demand are set forth by Blumenfeld (3).

Perhaps the most extensive density analyses are those contained in the Chicago, Pittsburgh, Detroit, St. Louis, Chattanooga, Twin Cities, and Washington metropolitan area studies (11 through 16). Heavily predicated on land-use analysis, they contour density throughout the urban area. Density, in turn is correlated with age patterns, car ownership, and travel mode. Some of the pertinent findings from these studies are given in Table 9.

The studies clearly show the reductive effect of density on total trip generation, both between various cities, and within each city. (Trip generation is generally expressed as a - bx, or a - b log x, in which x is a density function.) There is an especially close similarity between the effects of density on per capita trip generation in Chicago, Detroit, and Pittsburgh (Eqs. L, N, and P - Table 9).

In almost every case, over-all trip generation decreases as cities or neighborhoods become more dense. This is because in old, densely populated central cities many trips are made as pedestrians and are not reported in the origin-destination data. Trips to the corner drug store, neighborhood grocery, school or church often can be made by foot; moreover, opportunities for trip consolidation increase.

Other reasons for lower trip generation in high-density areas are also significant. These areas often reflect low car ownership and low incomes; both factors correlate with low rates of trip generation.

TABLE 11

CAR OWNERSHIP

Car Ownership	County	State	People per Car
Highest	Broward	Fla.	2.1
	Los Angeles	Calif.	2.3
	Orange	Calif.	2.3
	Santa Clara	Calif.	2.3
	Multnomah	Ore.	2.3
	Pinellas	Fla.	2.3
Lowest	New York	N. Y.	9.4
	Bronx	N. Y.	6.6
	Kings[a]	N. Y.	6.0
	Suffolk[b]	Mass.	4.4
	Queens	N. Y.	4.1
	Philadelphia	Pa.	4.1

[a] Brooklyn.
[b] Boston.

TABLE 12

CAR OWNERSHIP IN SELECTED CENTRAL CITIES[a]

City	1960 Pop. Density	Car Ownership (%)				
		One	Over One	Subtotal	None	Total
Boston	14,586[b]	52	11	63	37	100
Washington, D.C.	12,442	50	15	65	35	100
St. Louis	12,296	53	9	62	38	100
Detroit	11,964	56	21	77	23	100
Baltimore	11,886	51	10	61	39	100
Cleveland	10,789	57	14	73	27	100
Milwaukee	8,137	61	13	74	26	100
Minneapolis-St. Paul	7,326	58	17	75	25	100
Cincinnati	6,501	54	19	73	27	100
Seattle	6,295	53	21	74	26	100
Dallas	2,428	52	30	82	18	100

[a] Source: U. S. Department of Commerce, 1960 Census.
[b] Inasmuch as figures relate to Central Cities, Boston's density tends to overstate actual density because it excludes adjacent cities which in many respects are central city.

Car Ownership and Use

Car ownership and use are mainly related to socio-economic status in the community; however, they are also related to population concentrations. An analysis of car ownership in 115 leading U. S. counties (Table 10) shows that 1961 car ownership ranged from 2.1 persons per car in Broward County, Fla., to 9.4 persons per car in Manhattan. Sixty-eight percent of the counties had three people or fewer per car, and 95 percent of all counties had four or fewer people per car. The remaining 5 percent were counties lying wholly within, or dominated by, a central city. By way of comparison, the counties with the highest car ownership were found in Florida and Southern California (Table 11).

The highest densities of car ownership (cars per square mile) are found in the old central cities. Manhattan, for example, with 77,000 people per square mile averages nearly 8,500 cars per square mile. Los Angeles with a density of 5,500 people per square mile averages less than 2,500 cars per square mile.

A comparison of automobiles available for use in central cities, urban fringes, and rural portions of 11 selected standard metropolitan areas, clearly indicates that the lowest car ownership ratios are in the central cities—Detroit, Boston, St. Louis, Washington, D.C., Cleveland, Baltimore, Minneapolis-St. Paul, Milwaukee, Seattle, Dallas, and Cincinnati (Table 12). Of all households in central cities 29 percent did not have cars available for use, compared with 10 percent in the urban fringe, and 7 percent in the rural portions; 22 percent of all SMA households had no automobiles available for use.

The effects of central city density on automobile availability are shown in Figure 9. The availability of one car remains relatively constant at all density levels; however, multiple car ownership decreases as density rises, with a corresponding increase in the proportion of households with no automobiles available. The patterns suggest a series of contour lines for various levels of car availability, superimposed on population-density coordinates.

At each level of income, people in large and dense cities tend to own fewer cars than people with comparable incomes in other cities. Studies of car ownership and income in Canadian cities, for example, showed the lowest rates of ownership in Montreal and Quebec at every income level (17).

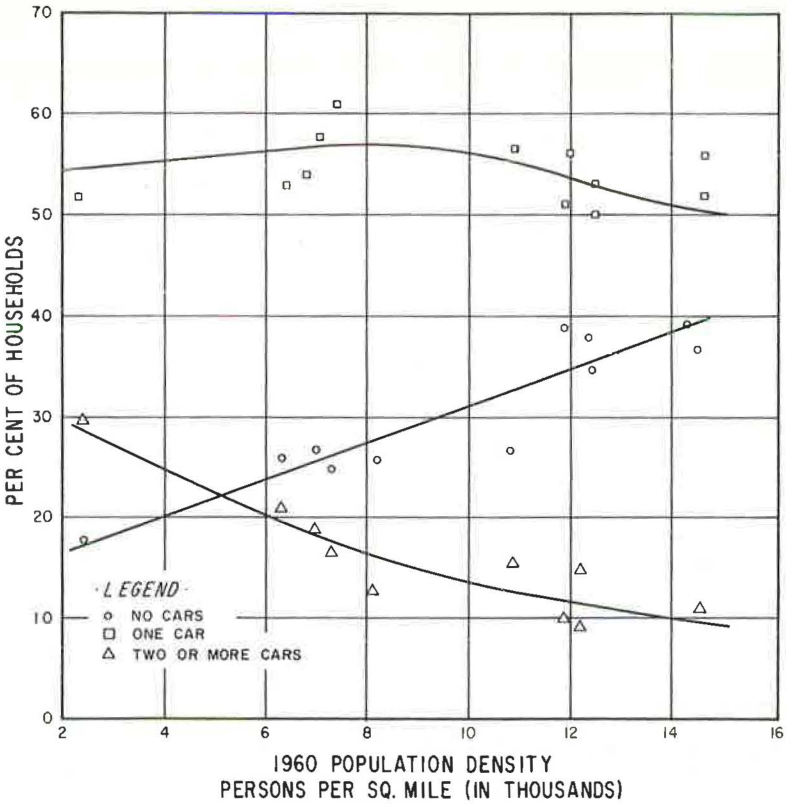

Figure 9. Effect of central city density on car availability.

Usually, there are more car owners in single family residential areas than in high density apartment districts. Car ownership ceilings, for example, are achieved when incomes exceed $9,000; at this income level, the effects of density on ownership (18) are given in Table 13.

The effects of dwelling unit type on car ownership, summarized in Table 14 for Chattanooga, clearly indicate the correspondence between low car ownership and high population density. Single-family dwellings averaged 1.12 cars per dwelling unit as compared with 0.73 cars per dwelling unit for two-, three-, and four-family dwellings, and 0.41 cars per dwelling unit for five-family dwellings. Of the single-family dwellings 17 percent had no car, as compared with 38 percent of five-family units. Multiple-car ownership was highest for single-family dwellings. Because car ownership affects rates of trip generation, the significance of these findings is quite clear. High-density areas are often closer to employment and commercial outlets, thereby minimizing the need for private transportation; often public transportation is efficient, and serves as a deterrent to multiple car ownership.

TABLE 13

EFFECTS OF DENSITY ON OWNERSHIP

Density (sq ft per family)	Cars per 1,000 Persons [a]
1,000	200
2,500	300
5,000	400
10,000	500

[a] Approximate.

Trip Length

One consequence of reduction in den-

TABLE 14

EFFECT OF DWELLING UNIT TYPE ON CAR OWNERSHIP, CHATTANOOGA 1960[a]

Type Dwelling Unit	Dwelling Units	Cars	Cars per Dwelling Unit	Car Ownership (%)		
				None	One	Two or More
1-family	55,202	61,903	1.12	16.6	57.8	25.6
2- to 4-family	10,986	8,042	0.73	38.2	51.6	10.2
5-family or more	4,548	1,855	0.41	6.35	32.8	3.7
Other	1,772	1,165	0.66	46.8	41.6	11.3
Total	72,508	72,965	1.00	23.7	54.5	21.8

[a] Source: (16).

sity has been the changing commercial structure. Distances between retail outlets have of necessity increased, thereby extending the geographic spread of trading areas. New establishments become auto-oriented and locate on larger sites where off-street parking is also provided. Concurrently, outlets tend to consolidate—with a trend toward fewer and larger service units. As a result, the corner grocery store has rapidly become anachronistic, although it is still prevalent in old, high-density central cities; e.g., New York.

The implications on trip length are apparent. A 100 percent reduction in densities, for example, could increase the radius of a trade area about 60 percent. Although average trip lengths to commercial outlets may have increased, the result on over-all trip lengths is not as simple; often a trip on foot has been replaced by a trip via car. Although the specific shopping trip may have increased from a few blocks to a few miles, the over-all trip length for all trips might have actually reduced. What is significant, however, is the increase in number of total trips in vehicles, and total vehicle-miles of travel per capita.

TABLE 15

COMPARATIVE TRAVEL DATA FOR SELECTED URBAN AREAS

Urban Area	Population Time of Survey	Density		Daily Veh-Mi per Capita[b]	Internal Trip Length[c]
		Urban Area Population	Central City		
Chicago	5,169,663	6,209	15,836	5.9	5.0
Detroit	2,968,875	4,834	11,964	8.5	4.4
Washington	1,568,522	5,308	12,442	5.5	3.9
St. Louis	1,275,454	5,160	12,296	6.7	4.4
Pittsburgh	1,472,099	3,437	11,171	6.8	3.9
Kansas City	857,550	3,262	3,664	7.8	3.9
Phoenix	387,395	2,222	2,343	9.1	3.7
Nashville	357,585	2,682	5,892	7.5	3.4
Chattanooga	241,709	2,302	3,542	N.A.	2.8
Charlotte	202,262	2,836	3,111	6.9	3.1

[a] Source: (10, 16).
[b] Internal and external travel within study area.
[c] Over the road.

A comparison of vehicle-miles per capita with urban area size and density (Table 15) tends to reflect the increase in the average individual's vehicular travel in less dense and small urban areas. Central city density appears to reflect best the restraints on auto travel, the availability of public transportation and the lesser trips per capita.

Internal trip lengths in most cities approximated 4 miles, and comparatively little variability was found from city to city. (Variabilities encountered in measuring trip lengths have limited the precision of the analyses; data in Table 16 were largely based on a manual sampling of various origin-destination linkages.) Although there appears to be a slight increase in trip length with urban area size and density, the fit appears better when population alone is considered. Obviously, the increase in short non-work car trips in low-density areas may tend to reduce over-all trip lengths.

Trip lengths of workers tend to be shortest for those workers living in rented dwelling units. Work trip lengths by home owners in Chattanooga averaged about four miles (all modes) compared to three miles for renters (Table 17). The rental units are located closer to employment centers and closer to downtown, 65 percent of all rental units being within 3 miles of downtown Chattanooga.

Public Transportation Usage

Perhaps the most significant effect of density on urban travel is the close correla-

TABLE 16

TRANSIT RIDING IN SELECTED CITIES, 1959[a]

City	Approximate Transit Rides per Capita per Year	Population Density per Sq Mi of Area Served by Transit (thousands)	Area (sq mi)		Population of Area Served (thousands)
			Served by Transit	Central City	
New York	294	24.8	314	314	7,782
New Orleans	181	10.3	58	199	597
Chicago	145[b]	17.6	213	208	3,757
Boston	132[b]	13.3	114	45	1,521
Philadelphia	119	6.8	414	127	2,805
Milwaukee	106	8.0	127	91	1,004
St. Louis	82	9.2	130	60	1,200
Buffalo	79	9.9	79	43	778
Seattle	77	6.6	88	88	580
Atlanta	74	4.3	175	100	750
Rochester	70	4.6	100	37	463
Memphis	70	5.5	91	91	500
Cincinnati	70	6.1	109	76	674
Harrisburg	66	4.6	30	12	137
Detroit	65	11.9	182	140	2,158
Pittsburgh	63	4.8	265	55	1,267
Providence	56	2.0	244	19	500
Indianapolis	55	7.8	61	61	475
Minneapolis	52	6.3	198	59	1,250
Kansas City	50	7.7	98	81	750
Akron	33	5.0	70	54	350

[a] Source: American Transit Association and U. S. Census data; also see "Future Highways and Urban Growth."

[b] Includes surface rapid transit.

TABLE 17

WORK TRIP LENGTHS, CHATTANOOGA, 1960[a]

Mode of Travel	Average Trip Length (Airline)					
	White Collar Workers		Blue Collar Workers		All Workers	
	Rent[b]	Own[c]	Rent[b]	Own[c]	Rent[b]	Own[c]
Auto driver	3.37	4.15	3.11	4.27	3.22	4.20
Auto passenger	2.98	4.41	2.70	3.87	2.82	4.17
Transit	2.62	3.52	3.00	3.55	2.91	3.53
Truck	2.16	3.31	1.81	3.62	1.92	3.54
School bus	-	-	2.90	0.50	2.90	0.50
Taxi	0.97	1.83	1.83	2.20	1.67	1.96
Walk	0.59	1.03	0.84	0.75	0.76	0:79
Cycle	-	-	3.70	1.75	3.70	1.75
All modes	2.68	4.09	2.50	3.72	2.56	3.92

[a] Source: (16).
[b] Living in rented units.
[c] Owning place of residence.

tion between high density and high usage of public transportation. Transit depends on spatial and temporal concentration of movements; thus, intensively developed central business districts, and high-density radial corridors are conducive to transit usage.

These effects all interact. Central business districts generally developed with greatest intensities in the large, old, dense central cities; often their intensities were reinforced by radial (rapid) transit routes. Thus, today, the greatest density of downtown destinations (and the greatest total square feet of floor area) are found in New York, Boston, Chicago, Philadelphia, and San Francisco. (Rapid transit systems exist today in the first four cities, as well as in Cleveland; street-railway operations in San Francisco include private right-of-way and two tunnels.)

Dense residential areas often developed prior to, or concurrently with, mass transit routes--particularly along rapid transit routes. Hence, their "transit orientation" is usually toward downtown.

By precedent, and of necessity, low income components of the population generally settled in dense areas. Often, not being able to afford cars, they became captive transit riders.

The coincidence of city age, high population density, low levels of auto ownership and high usage of public transportation in Chicago are shown in Figure 10. Also, in three radial corridors, high transit usage, high density, and low auto-ownership coincide with principal rapid transit routes.

In the Washington, D.C., area, the pattern is somewhat similar. Residents of the District of Columbia accounted for 73 percent of all 1955 transit trips in the metropolitan area (19, Table XVIII). Of over 1,000,000 trips made by D.C. residents, 40 percent were made by transit. Of 1.2 million trips made by Maryland and Virginia residents, only 13 percent were made by transit. Though patterns are not static, and changes in transit levels are continually taking place, the problems of achieving extensive transit patronage from low density areas are readily apparent.

Various equations pertaining to transit usage are summarized in Table 18. In virtually every case, high density (in combination with low car ownership) tends to increase transit usage. Most correlation coefficients exceed 0.7.

Rapid transit depends on, and simultaneously fosters high densities, generally developing where central city densities exceed 14,000 people per square mile. New York City, with a density of 25,000 people per square mile, accounts for three-quarters

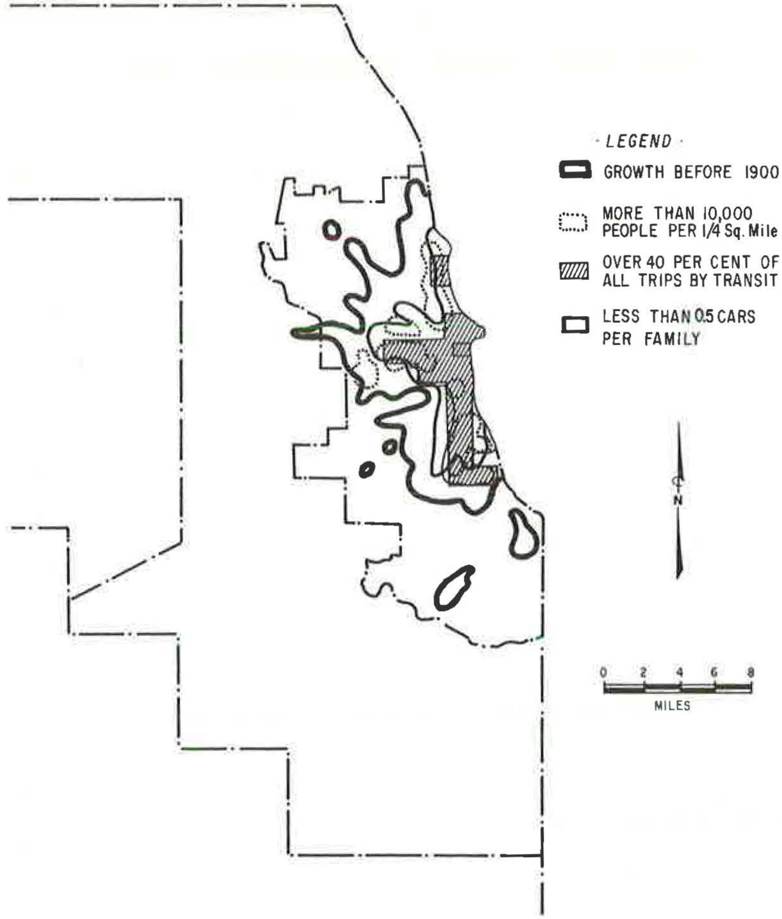

Figure 10. Coincidence of city age, density, car ownership, and transit use.

of the Nation's rapid transit riding. In most American cities today, primary rapid transit patronage comes from areas 4 or more miles from downtown because, within the first 4 miles, comparatively little time advantages usually accrue to rapid transit riders; for example, the spacing and patronage of the Chicago Rapid Transit stations in relation to distance from the CBD, and the heavy use of outlying stations in Boston and Philadelphia. Thus, sizeable concentrations of people within a 4- to 8-mile band around downtown appear conducive to good rapid transit patronage.

Transit "riding habits" for selected cities in relation to the population density of the areas served by transit are shown in Figure 11. The data (based on American Transit Association figures) again pinpoint the general increase in per-capita transit riding, as cities become dense. The relationships are not precise; however, information is not given for "non-member companies." Factors such as service and fare differentials, concentration of activities within the central area, and alignment of population along specific corridors all obviously influence patronage and affect the plotted values.

It is no coincidence that transit prospers in dense areas and simultaneously encounters problems in serving auto-oriented suburbia. The greater spread of the population reduces the number of people within easy walking distance, and hence, potential to transit. Simultaneously, routes are extended and the vehicle-miles operated per passenger increases. Moreover, auto-ownership is high, and trip patterns are extremely diffuse.

Freeway System Implications

With most urban growth taking place in suburban areas, and hence, strongly oriented toward automobile travel, needs have been clearly demonstrated for expanding freeway systems. Proposed freeway systems provide about 1 mile of route for 10,000 people (Table 19). In the largest cities, the ratio is slightly less; in smaller cities it is often

TABLE 18

SUMMARY OF TRANSIT TRIPS AS RELATED TO POPULATION DENSITY

Study	Year	Eq. No.	Equation[a]	Correlation
Between Several Cities:				
Some Aspects of Future Transportation in Urban Areas; Levinson-Wynn	1962	A	$Y_1 = 0.5\ x_1x_2(10^{-3})$	Not cited
		B	$Y_2,\ Y_3 = f(x_1x_2)$	
Factors Influencing Mass-Transit and Auto Travel in Urban Areas Public Roads, Adams (1959)	1959	C	$Y_3 = 2.6466 + 3.7084 \log P + 0.3912 \log E + 2.3757 \log T + 0.4918 \log U - 0.9708 \log M$	Not cited
Some Social Aspects of Mass Transit in Selected American Cities, Joel Smith, Mich. State Univ.	1962	D	Transit use correlates with density. Older cities are generally areas of high density.	r = 0.67; r = 0.69
Leo Schore, Univ. of Wis.	1962	E	Percent of transit trips to work correlates with city size, age, and density. Highest correlation 0.75 with city age.	r (multiple) = 0.80
Within Cities:				
Chicago	1956	F	$Y_3 = 15.5 + 21.745 \log x_4 - 16.72 \log x_5$	0.87
Pittsburgh	1960	G	$Y_4 = 38 + 2.35\ x_3 - 0.0111\ x_3^2$	+0.75
		H	$Y_5 = 147 + 1.41\ x_3 - 0.0091\ x_3^2$	+0.30
		I	$\log Y_6 = 3.30 - 0.91 \log x_3$	-0.75
		J	$Y_7 = 3 + 3.2\ x_3 - 0.026\ x_3^2$	+0.75
		K	$Y_8 = 84 + 8.9\ x_3 - 0.094\ x_3^2$	+0.52

[a] Dependent Variables:

- Y_1 Transit trips per person
- Y_2 Percent of CBD trips by transit
- Y_3 Percent of urban area trips by transit
- Y_4 CBD transit trips per 1,000 people; one-car households
- Y_5 CBD transit trips per 1,000 people; no-car households
- Y_6 School transit trips per 1,000 people
- Y_7 Other transit trips per 1,000 people; one-car households
- Y_8 Other transit trips per 1,000 people; no-car households

Independent Variables:

- x_1 Urbanized area population density
- x_2 Households per car
- x_3 Net residential density per acre
- x_4 Population per 1,000 sq ft residential land
- x_5 Autos per 1,000 people
- P Population over 5 years old in survey area
- E Economic factor depending on population, workers, households, auto ownership
- T Transit service factor depending on vehicle-miles operated, urbanized area in square miles, speed, parking conditions
- U Land use distribution factor
- M Urbanized land area in square miles

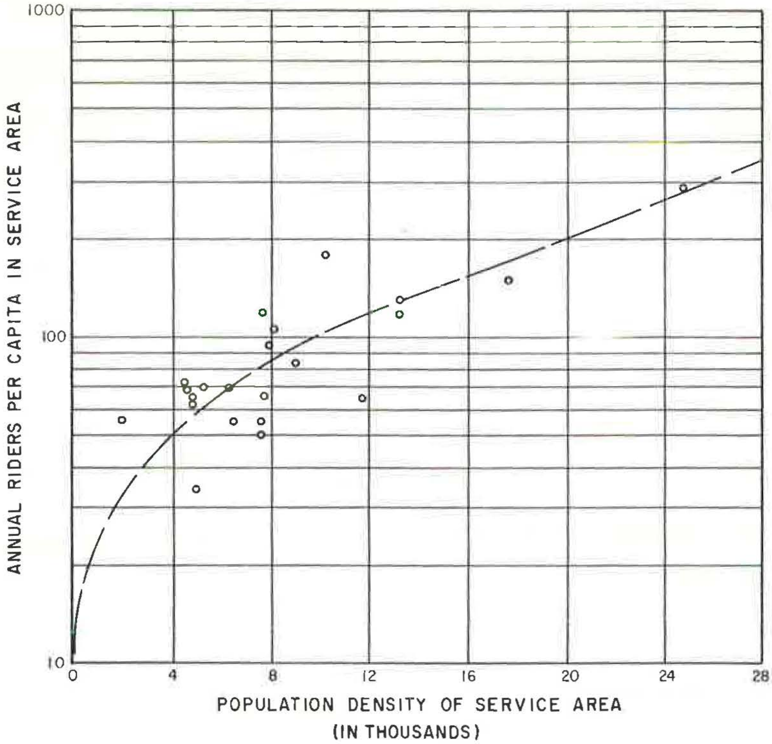

Figure 11. Transit riding habit in relation to population density.

slightly more. To some extent, this is offset by the greater number of lane-miles in the larger urban areas. In Chicago, densest of the areas tabulated, only 0.67 miles of freeway are provided per 10,000 residents; however, existing and proposed rapid transit and commuter lines approximate 0.42 miles per 10,000 residents. Stated an-

TABLE 19

COMPARATIVE ASPECTS OF FREEWAYS USAGE IN SELECTED URBAN AREAS[a]

City	Year	Population	Miles of Freeway	Miles per 10,000 People	Freeway Use			
					Percent of Total Trips	Percent of Veh-Mi	Avg. Trip Length on Freeway	Avg. Vol. per Mi of Rt.
Chicago	1980	7,802,000	520b	0.67	35.4	51.0	8.9	64,000
Los Angeles	1960	6,448,800	515	0.80	--	--	--	--
Detroit	1980	4,400,000	350	0.80	29.0	48.3	9.5	70,000
Washington	1980	2,720,700	270	1.00	53.0	58.5	6.6	60,810
St. Louis	1980	1,721,360	160	0.93	40.9	55.5	8.0	60,560
Kansas City	1980	1,340,220	153	1.14	38.2	52.8	9.1	56,100
Phoenix	1980	1,250,000	141	1.13	27.0	30.8	6.2	39,600
Oakland	1980	1,016,700	134	1.32	58.0	54.0	9.0	57,600
San Diego	1960	836,700	99	1.18	--	--	--	--
Nashville	1980	467,113	64	1.37	31.0	38.0	7.6	33,400
Sacramento	1960	438,127	57	1.30	--	--	--	--
Charlotte	1980	409,735	39	0.96	30.8	32.4	3.9	29,800
Chattanooga	1980	344,528	54	1.57	32.0	35.0	5.6	22,500
Fresno	1960	213,400	24	1.12	--	--	--	--
Reno	1980	146,000	12	0.82	30.0	35.0	4.0	24,590
Santa Rosa	1960	28,800	6	1.55	--	--	--	--

[a]Sources: (10, 11); data presented by K. Moskowitz at AMA Symposium (Oct. 1960).
[b]Also an estimated 330 miles of rapid transit and commuter railroad; 0.42 miles per 10,000 people.

other way, the freeway system mileage for Chicago (future) and Los Angeles (present) are about the same; yet the Chicago area (1980) includes 1.4 million more people; perhaps these people may be considered as "served" by the rapid transit systems.

Population density obviously affects the density of trip origins, and hence, freeway spacing and demands. Where densities are greatest, freeway systems are spaced the closest. It has been shown that, based on the criterion of 1 freeway mile per 10,000 people, it is difficult to provide desired capacities where substantial areas of central cities exceed 20,000 people per square mile; if the criterion is changed to one mile per 15,000 residents, the critical density becomes 30,000 (1). These critical densities would require 2-mile freeway grids.

The Chicago Area Transportation study developed relationships between trip destinations, densities, and freeway and arterial street spacing. Based on varying levels of vehicle trip destinations per square mile, the estimated "least cost freeway spacing" for Chicago (1980) approximated 3 to 4 miles; 20-30,000 vehicle destinations per square mile. This corresponds approximately to a gross density of 20,000 to 35,000 people per square mile (11, vol. 3). Even with an infinite trip destination density, 3 miles was found to be the limit of the "least cost" spacing.

These criteria, although varying slightly in concept and detail, clearly indicate the effects of density on freeway system requirements.

Obviously, freeway costs vary with density of development. Because construction costs, for example, may vary linearly with density, at some point (perhaps where gross population densities exceed 20,000 people per square mile) construction of rapid transit may be less expensive.

Area requirements of freeways also increase as densities get greater. Based on the 1-mile per 10,000 population criterion, 5 to 6 percent of all urban land would be devoted to freeways where an over-all density of 10,000 people per square mile exists. Over 10 percent of all land would be used by freeways when densities exceed 18,000 people per square mile.

Because in practice freeway systems adapt to over-all land use, topographic, and continuity requirements, some refinement of these values actually takes place. Actual freeway systems (Table 20) will occupy from 2 to 6 percent of a central city's land, and from about 1.4 to 3.0 percent of an urban area's land, depending on the system extent, and the densities or areal expanse of specific urban complexes. Often, the areas devoted to freeways will be offset by reducing collector street space needs within

TABLE 20

PROPORTION OF LAND DEVOTED TO FREEWAYS IN SELECTED URBAN AREAS

Area	Central City			Entire Area		
	Approx. Mi. of Freeway	Per Sq. Mi. of Area	Percent of Area Devoted to Freeways [a]	Approx. Mi. of Freeway	Per Sq. Mi. of Area	Percent of Area Devoted to Freeways [a]
Chicago	140	0.62	5.5	524	0.42	2.8
St. Louis	60	0.99	5.0	160	0.57	2.8
Chattanooga	16	0.43	2.2	54	0.28	1.4
Detroit	-	-	-	350	0.49	2.5
Los Angeles	-	-	-	515	0.34	1.6
San Diego	-	-	-	99	0.38	1.8
Sacramento	-	-	-	57	0.38	1.8
Fresno	-	-	-	24	0.34	1.6
Santa Rosa	-	-	-	6	0.42	1.4

[a] Data for California and Chicago as developed by others; data for other cities based on average freeway width of 250 to 300 ft.

redevelopment areas. Stated in other terms, freeways will occupy up to 3 percent of an urban area's land; simultaneously freeways will accommodate up to one-half of all vehicle-miles of urban travel.

Fewer freeway miles per capita are actually provided within the central city. This is largely because of the availability of arterial streets and transit facilities, shorter trip lengths, and closer distances between key facility links.

The number of families displaced is also directly related to the density of areas traversed by freeways. One mile of freeway traversing an area with a density equivalent to 10,000 people per square mile displaces about 5,000 to 6,000 families; with densities of 5,000 people per square mile, only 2,500 to 3,000 persons would be displaced. Thus, the social impacts of freeways are greatest in dense urban centers.

INTERACTIONS AND IMPLICATIONS

There are obvious interactions between density patterns and transportation facilities; some interpretative analyses are cited herein. Transportation often serves as a catalyst in precipitating density changes. Circumferential expressways (such as Route 128 around Boston, Route 401 around Toronto, and the Beltway around Baltimore) have spawned many peripheral commercial and industrial developments; by diffusing major generators throughout suburbia, they have altered trip opportunity patterns. Similarly, radial highway and transit routes have brought outlying areas closer to downtown in terms of travel time, and have thereby tended to increase their downtown orientation; for example, Fairfax County along the Shirley Highway; San Mateo along the Southern Pacific; White Plains along the New York Central.

Downtown Orientation

Accordingly, two special investigations were made to ascertain the relationship between downtown orientation and population densities; residential distribution of over 100,000 employees in the Loop District of Chicago (20) was compared with the population in each square mile of the city; CBD trips from various districts in Pittsburgh (1960) were related to the population and net residential density of each district. Hence, the data represent two cities in two distinct time periods. Both analyses indicated that densely populated areas per se are not necessarily CBD oriented. Characteristics of specific sectors appear more pertinent—in particular, their relative accessibility (travel time) to downtown as compared with accessibility to other major generators.

In Chicago, the greatest downtown orientation was found along the rapid transit routes, and at key suburban railroad stations within the city. The areas that developed after rapid transit lines were extended (usually 5 to 10 miles distant from downtown) showed downtown attraction of over 100 CBD employees per 1,000 population, as compared with a city-wide average of about 50. The sector along the North Lake Shore, generally removed from major industrial centers, had the largest contiguous area of high downtown attraction. The old, very dense, centrally-located residential areas did not exhibit a strong affiliation for downtown. In 1946, a study of Loop shopping attractions prepared by "Downtown Shopping News" showed the greatest number of CBD shoppers per family from the same general areas as found in 1916 (21).

In Pittsburgh, downtown orientation of several sectors increased as areas became more dense. Variabilities, however, were too great to permit any generalizations. Again, densities were more a function of particular sectors or community characteristics. The areas located along a general east-northeast-to-west-southwest axis exhibited the greatest downtown attraction; in particular, the Schenley Heights-Bloomfield-Bellefield area on the east, and the South-Hills-Mount Lebanon areas on the southwest. The areas on the southwest are served by both the Penn Lincoln Parkway, and the Castle Shannon-West Liberty private-right-of-way transit routes; they are removed from major industrial centers.

Catalytic Effects of Transportation

In many urban areas public transportation facilities preceded land development, making new areas readily accessible to downtown. Often, these areas became "choice" downtown-oriented locations and were densely settled. Effects were most pronounced in corridors where other equally compelling factors created pressures for development; such as climate, prestige, and proximity of parks. Freeways have had a similar effect, although they have been less instrumental in achieving "downtown orientation."

Thus many corridors that developed after rapid transit routes were initially in high-to-medium income, high-density areas; for example, the Grand Concourse and Queens Boulevard, New York; Shaker Heights, Ohio; Edgewater, Chicago. Through time, many of these areas have become superseded by newer communities, with some lowering of income levels, and shifts in resident population; the newer high-density, high-income areas tended to develop beyond the existing settlements, often at lower densities.

Future Densities

Most projections of existing growth patterns show a continuation of the trend toward low-density suburban living (10) and leveling of densities. Largely a reflection of an affluent society, there has been little evidence to date of en masse return to high-density living. The most rapid urban expansions have occurred in the southwestern parts of the nation; these are basically low density in nature. Even in more densely populated areas, there has been little evidence of large-scale redensification. Should, a large-scale return to high-rise apartment living occur, some centralization of commercial activity may also result; obviously, some readjustment of transportation systems would be required.

The factors influencing urban densities include the following:

1. Growth pressures within an urban area. Without growth, there is little reason for intensification of land use.
2. Availability of land to absorb growth. Where land is available (viz., Texas plains-cities) horizontal urban expansion will be most likely. Where land may become scarce (viz., the San Francisco Bay area, midtown Manhattan) densities will probably increase.
3. Topographic influences and limitations. Topography serves the dual effects of (a) precluding certain land from development, and (b) affording certain areas with advantages of site, climate, or accessibility; for example, Mount Royal, Montreal; the Santa Monica Mountains, Los Angeles; the Lake Shore, Chicago. Topographic restraints, and incentives may be conducive to higher densities and may encourage corridor growth.
4. Climate. Parts of a metropolitan region affording cooler summers (e.g., the West Los Angeles area in contrast to the San Fernando Valley), milder winters (San Francisco in contrast to East Bay area) often tend to be more attractive as residential areas; hence more valuable and more conducive to redensification.
5. Prestige and inertia. Sectors of an urban area where growth has traditionally been choice, and where prestige factors command higher rents will increase in density; for example, the Northwest sector of Washington, D.C.
6. Policy planning decisions. Metropolitan area and central city plans and policies relating to control and distribution of future land use and development will also influence densities.
7. Transportation systems and proposals. Transportation will affect the timing, relative values, and importance of the previously mentioned factors.

Transportation System Implications

With the urban areas expanding, and trip linkages, patterns, and interactances increasingly diffuse, private vehicle travel and freeway systems will become even more vital. Transportation requirements can generally be categorized into three broad classes:

1. Service between low-density areas.
2. Service between high- and low-density areas.
3. Service between high-density areas.

Service between low-density areas will largely be by private automobile, with freeway systems providing the means for interconnecting low- and medium-density parts of the urban region.

Trips between high- and low-density areas can be served conveniently by both public and private transportation.

Trips between high-density areas (more specifically between the CBD and outlying high-density areas) afford the most attractive opportunities for public transportation.

Thus, rapid transit will, in particular, provide efficient service for two basic types of trips: trips wholly between high densities, and trips between high and low densities; in a sense, both high- and low-income riders will require service. Because these areas have different riding characteristics and service requirements, great precision will be called for in system design, planning, and operation. A principal value of rapid transit will be its ability to maintain and increase the downtown-orientation of outlying areas, where or if such central orientation is considered desirable.

Generally, service between the CBD and dispersed areas (such as the Illinois part of the St. Louis Metropolitan Area, Marin County north of San Francisco, the Washington area of Virginia, and the North New Jersey area of New York City) may benefit from the ubiquity of the express bus. Service between the CBD and high-density areas will require penetration by high-capacity rapid transit; and in some instances (in the largest urban complexes) support rail rapid transit. Joint use of freeways by express transit and autos will be mainly limited to (a) areas where freeways penetrate, and not skirt, high-density areas, and (b) service between the CBD and low-density areas.

Increases in urban trip opportunities have tended to decrease the density of downtown trips from most parts of the urban areas. The number of areas from which downtown attracts people has increased much faster than the number of trips to downtown.

To maximize downtown orientation of communities along transit routes (where such orientation is considered desirable) travel times to the CBD should be minimized. This minimization is especially desirable along sectors or corridors where growth pressures may encourage higher densities, and where rapid transit may serve as a key catalyst toward redensification. This might call for comparatively high-speed, non-stop express service between the CBD and principal outlying points. With bus facilities, this can be provided by trunkline express operations with local "branches" into selected areas. With rail service, this might entail the provision of a third track for peak-hour express service, or for the combination of "conventional" and commuter rapid transit service on the same facility. Fares and load ratios could vary for each major zone.

SUMMARY AND LIMITATIONS

This paper has explored in a general way the effect of population density on urban transportation requirements, and shows how urban travel and population densities interact.

1. There has been a general tendency for central city population density to be greater in large cities. The patterns of increase, however, vary widely and are strongly affected by regional differences and topographic conditions. City age (in combination with city size) also affects densities. Large old cities are consistently the most dense.

2. The distribution of urban population by various levels of density appears regular, when urban areas are compared. Further investigation of the similarity in density patterns might provide a basis for predicting the proportions of urban populations living at various percentages of average net residential densities.

3. The information analyzed herein suggests the use of two parameters (population and density) in appraising over-all transportation requirements from city to city. Superimposed on these coordinates, a family of contours might delineate urban areas with comparable transportation situations and needs.

4. Dense urbanization generally inhibits car ownership and, hence, total travel generated by urban residents.

5. Old, intensively developed cities generally have a high dependence on public transportation. Public transit patronage increases in general accord with density,

although again factors such as CBD concentration, corridor alignment of population, and quality of service influence usage. Rapid transit has been most successful where densities are the highest; although historically it has been instrumental in precipitating high densities in many areas, there is no assurance that these effects will continue.

6. Although freeway requirements in urban areas are predominantly related to population, planned systems usually provide more miles per capita in low-density urban areas. Planned freeway systems will occupy about 3 percent of an urban area's land and will accommodate about one-half of all vehicle travel. Long average freeway trip lengths suggest heavy freeway usage by suburbanites.

7. Downtown orientation depends on other factors than density per se. Proximity to downtown, in comparison with access to other major outlets, seems to be more significant. Areas preceded by rapid transit, for example, were shown to have very high downtown orientation. The density of downtown-oriented trips tends to decrease as trip-making opportunities throughout the urban region increase.

8. Although transportation is an important factor in influencing population densities, it is largely catalytic. Other key factors include (a) growth pressures within an urban area, (b) availability of land to absorb growth, (c) topographic influences and limitations, (d) climate, (e) prestige and inertia, and (f) planning policy decisions.

9. Urban transportation requirements fall into three broad classes: (a) service between low-density areas, (b) service between high- and low-density areas, and (c) service between high-density areas. The first will be served predominantly by automobile; the last afford attractive transit potentials. Service between high- and low-density areas will be provided by both public and private transportation.

10. Rapid transit will have to increasingly accommodate trips between downtown and both low- and high-density areas—two somewhat different services. A principal value of rapid transit lies in its minimization of travel times to the CBD (thereby increasing the "downtown orientation" of its service areas) in urban areas where it may be desirable to increase downtown orientation.

Although density is valuable in providing a basic criterion for comparing and evaluating urban transportation needs, many of the analyses and relationships are somewhat lacking in precision. Problems, for example, arise in consistent definition and delineation of urban limits, in accuracy of source data, and in measurement of densities within urban areas. Density figures and distributions do not fully reflect the magnitude and extent of corridor development. Obviously, much additional work remains. Certainly, collection of land-use and density information in conjunction with home-interview, origin-destination data is a step in the right direction.

REFERENCES

1. Levinson, H. S., and Wynn, F. H., "Some Aspects of Future Transportation in Urban Areas." HRB Bull. 326, 1-31 (1962).
2. "Land Use and Traffic Models." Jour. Amer. Inst. of Planners, 25: No. 2 (May 1959).
3. Blumenfeld, H., "Transportation in the Modern Metropolis." Queens Quart., 67: No. 4 (Winter 1961).
4. Wingo, L., Jr., "Transportation and Urban Land." Resources for the Future (1961).
5. Clark, T. F. C., "Urban Population Densities." Jour. Royal Statis. Soc., Series A, No. 114 (1951).
6. "Report on 'Backbone' Rapid Transit Routes for Los Angeles, 1961." Los Angeles Metropolitan Transit Authority (1961).
7. "Population Growth in the City of Chicago, 1900-1960." Chicago Plan Commission, Dept. of City Planning (Oct. 1961).
8. Mayer, H. M., "Moving People and Goods in Tomorrow's Cities." Annals Amer. Acad. Polit. Soc. Sci., Vol. 742 (Nov. 1945).
9. Bartholomew, H., "The Place of Public Transportation in Our Changing Cities." Paper, 1951 American Transit Assoc. Annual Meeting (1951).

10. Wilbur Smith and Associates, "Future Highways and Urban Growth." Automobile Manufacturers Assoc. (1961).
11. "Chicago Area Transportation Study, Final Report." U. S. Dept. of Commerce (1959-62).
12. "Detroit Metropolitan Area Transportation Study." U. S. Dept. of Commerce (1955).
13. "Pittsburgh Area Transportation Study." U. S. Dept. of Commerce (1961).
14. "National Capital Region, Traffic Engineering Study." Wilbur Smith and Assoc. (1958).
15. "A Highway Planning Study for the St. Louis Metropolitan Area." U. S. Dept. of Commerce (1959).
16. "Chattanooga Metropolitan Area Transportation Study." Wilbur Smith and Assoc. (1962).
17. Wynn, F. H., "Traffic Engineering: Characteristics Course Notes." Inst. of Transportation and Traffic Engineering, TE 210-Vol. 1A (1955).
18. Voorhees, A. M., "Traffic and Parking Needs Generated by Building Development." Traffic Engineering Study Week, Nice (1960).
19. "Mass Transportation Survey—National Capital Region—Traffic Engineering Study." (1958).
20. "Report of Chicago Traction and Subway Commission to the City Council of the City of Chicago, 1916." (1916).
21. Breese, G. W., "The Daytime Population of the Central Business District of Chicago." University of Chicago Press (1949).

Population Distribution and Population Movements in the United States

HENRY S. SHRYOCK, JR., Bureau of the Census

• AS IS TRUE of most relationships between different human activities, the relationship between the distribution of population, on the one hand, and the location of transportation facilities, on the other, is of a reciprocal nature. The availability of highways and the cost of travel along them in various kinds of vehicles influence the settlement pattern, including the types of residential structures that are built. Conversely, the existing or expected population distribution and the distances from homes to jobs, schools, shops, and recreational facilities affect the planning of highways. In one sense, highways are attracted by population concentrations because they must link large concentrations together. This might be called the macro-ecological sense (as distinguished from the micro-ecological sense) in which highways skirt population concentrations because of the costs of residential land. These various interactions between population distribution and the location and nature of highways, railroads, subways, etc., complicate the making of forecasts.

The population is not only growing fairly rapidly (adding about 3 million persons a year) but also, in several important respects, becoming more concentrated. In very general geographic terms, the Atlantic, Pacific, and Gulf Coasts and the shores of the Great Lakes are growing at the expense of the Nation's interior. In the 1950's, almost one-half (49 percent) of all the counties in the United States actually lost population. All of these counties lost because of net out-migration. In addition, 29 percent of American counties had net out-migration that was offset by natural increase (excess of births over deaths), so that they had only slight or moderate population growth. Obviously, then some counties had high rates of net in-migration. The counties with very high rates of net in-migration (Fig. 1) are mostly outlying counties within metropolitan areas, a few relatively "young" metropolitan areas, and counties in Florida and California. A comparison with the rates of net migration by counties for the 1940's would show a great deal of similarity.

Closely associated with the tendency of people to concentrate in certain geographic areas is the tendency of people to concentrate in cities. As part of its description of the distribution of people by the size of place in which they live, the Bureau of the Census classifies territory as "urban" or as "rural."

This classification is arbitary in that it uses a cutting score of 2,500, but a moderately higher or lower cutting score would show regional differentials very similar to those given in Table 1. Moreover, the cutting score could be raised or lowered somewhat without invalidating the statement that population in urban territory is growing faster than that in rural territory.

The definition of urban territory now in use is as follows:

> In general, the urban population comprises all persons living in urbanized areas and in places of 2,500 inhabitants or more outside urbanized areas. More specifically, according to the definition adopted for use in the 1960 Census, the urban population comprises all persons living in (a) places of 2,500 inhabitants or more incorporated as cities, boroughs, villages, and towns (except towns in New England, New York, and Wisconsin); (b) the densely settled urban fringe, whether incorporated or unincorporated, of urbanized areas; (c) towns in New England and townships in New Jersey and Pennsylvania which contain no incorporated municipalities as subdivisions and have either 25,000

Paper sponsored by Special Committee on Urban Transportation Research.

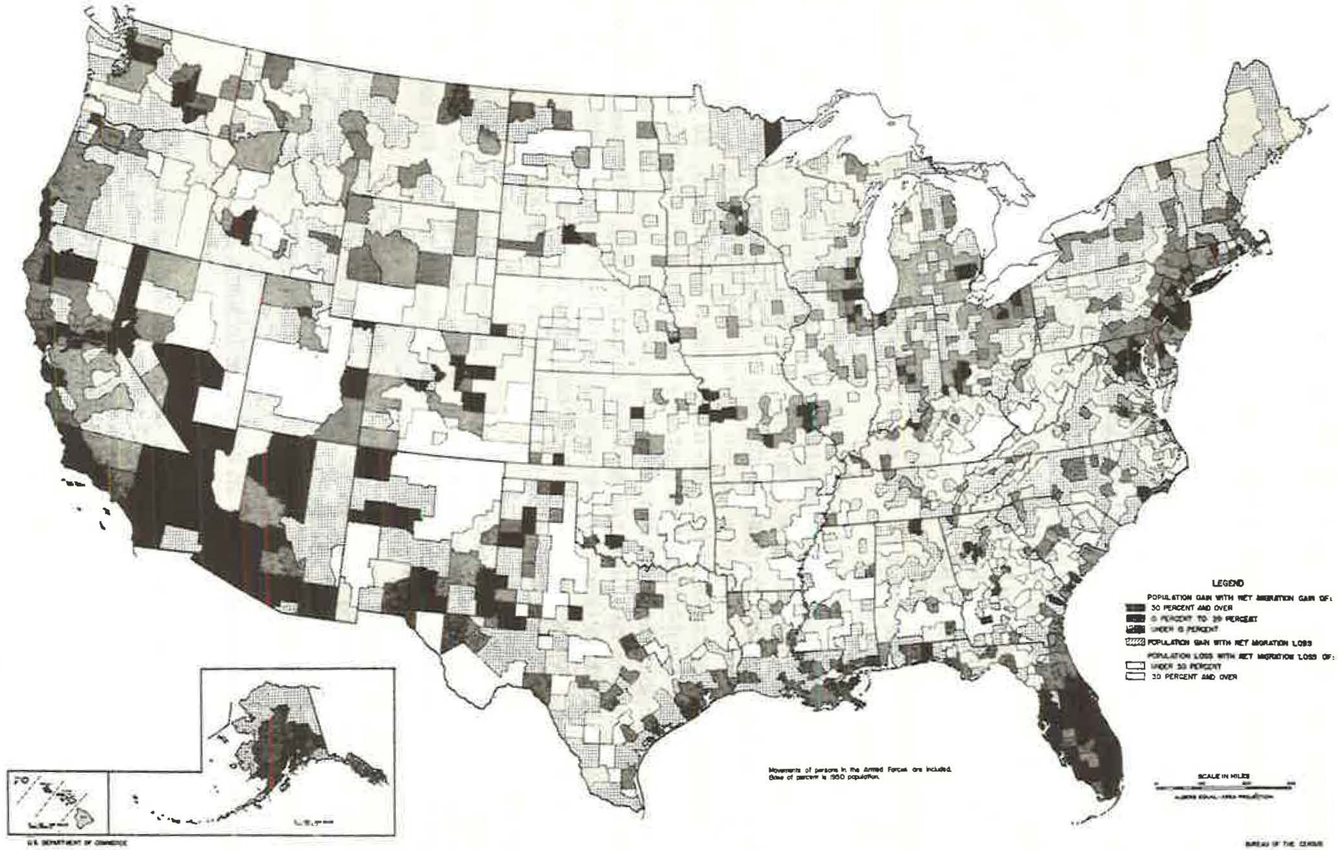

Figure 1. Net migration by counties: 1950 to 1960.

inhabitants or more or a population of 2,500 to 25,000 and a density of 1,500 persons or more per square mile; (d) counties in States other than the New England States, New Jersey, and Pennsylvania that have no incorporated municipalities within their boundaries and have a density of 1,500 persons or more per square mile; and (e) unincorporated places of 2,500 inhabitants or more.

Table 1 gives the urban and rural population in the 13 economic regions used by Bogue and Beale (1). Figure 2 shows these economic regions. Between 1950 and 1960, the urban population grew faster than the rural population in all but one of these economic regions. Indeed, in 5 regions and in the United States as a whole, the rural population decreased. Furthermore, in all but two of the regions, the urban population is in the majority and the two exceptions are now very close to being 50 percent urban.

This urbanization process has been taking place since the very first intercensal decade (Table 2). Study of the historic trend is complicated somewhat by the fact that a more realistic definition was introduced in the 1950 Census to include as urban not only the incorporated places of 2,500 or more but also the densely settled "urban fringes" around cities of 50,000 or more. On the old definition, the urban population comprised only 5 percent of the population in 1790, first exceeded 50 percent in 1920, and comprised 63 percent in 1960. The new definition gives 70 percent urban for 1960.

A town of 2,500 is, of course, a small place by modern standards. It is perhaps more striking to point out that cities of 50,000 or more and their urban fringes (which together are called "urbanized areas") account for over one-half the population (53 percent in 1960). Table 3 gives the distribution of the population by size of place. Lest the picture of the American as a dweller in big cities be overemphasized, about one-quarter still live in what the table calls "other rural territory"; i.e., villages and hamlets of less than 1,000 inhabitants plus the open country. Of these 48 million, however, only 13 million lived on farms.

Population change in a subdivision of the United States always has two broad components: (a) natural increase and (b) net migration. It may have a third—changes in boundaries. At the present time, practically all areas have an excess of births over deaths. Migration includes immigration and emigration from, and to abroad; but internal migration is numerically a much more important factor in population increase or decrease. Boundary changes result from such actions as annexations, retrocessions, and consolidations. Furthermore, when viewing population change for an aggregate, like urban territory or cities of 50,000 to 100,000, one must bear in mind that places enter or drop from the class when their population passes the critical size.

TABLE 1

POPULATION IN 1960 AND PERCENT CHANGE, 1950-60, BY URBAN-RURAL RESIDENCE[a]

Region	Name of Region	Population, 1960			Percent Change, 1950-60			Percent Urban	Percent Rural
		Total	Urban	Rural	Total	Urban	Rural		
I	Atlantic Metropolitan Belt	36,500,804	31,603,170	4,897,634	17.5	18.6	10.8	86.6	13.4
II	Eastern Great Lakes-Northeastern Upland	10,116,810	6,087,691	4,029,119	9.7	8.4	11.8	60.2	39.8
III	Lower Great Lakes	25,212,494	20,358,868	4,853,626	18.6	22.1	5.8	80.7	19.3
IV	Upper Great Lakes	5,750,213	3,351,722	2,398,491	14.5	27.9	-0.1	58.3	41.7
V	North Center (Corn Belt)	17,169,930	9,942,641	7,227,289	12.6	23.7	0.2	57.9	42.1
VI	Central Plains	6,013,853	3,608,311	2,405,542	16.4	41.6	-8.1	60.0	40.0
VII	Central and Eastern Upland	14,882,135	7,421,755	7,460,380	5.1	20.2	-6.6	49.9	50.1
VIII	Southeast Coastal Plain	16,391,896	7,788,643	8,603,253	9.6	32.3	-5.1	47.5	52.5
IX	Atlantic Flatwoods and Gulf Coast	11,812,018	8,971,391	2,840,627	48.1	63.2	14.7	76.0	24.0
X	South Center and Southwest Plains	8,993,054	5,434,377	3,558,677	8.3	40.8	-19.9	60.4	39.6
XI	Rocky Mountain and Intermountain	4,568,878	2,727,282	1,841,596	26.7	54.2	0.3	59.7	40.3
XII	Pacific Northwest	4,918,314	3,169,316	1,748,998	21.7	34.2	4.3	64.4	35.6
XIII	Pacific Southwest	16,992,776	14,805,449	2,187,327	50.1	61.6	1.4	87.1	12.9
	U. S. total	179,323,175	125,270,616	54,052,559	18.5	29.3	-0.8	69.9	30.1

[a]Adapted from (1) by permission of authors.

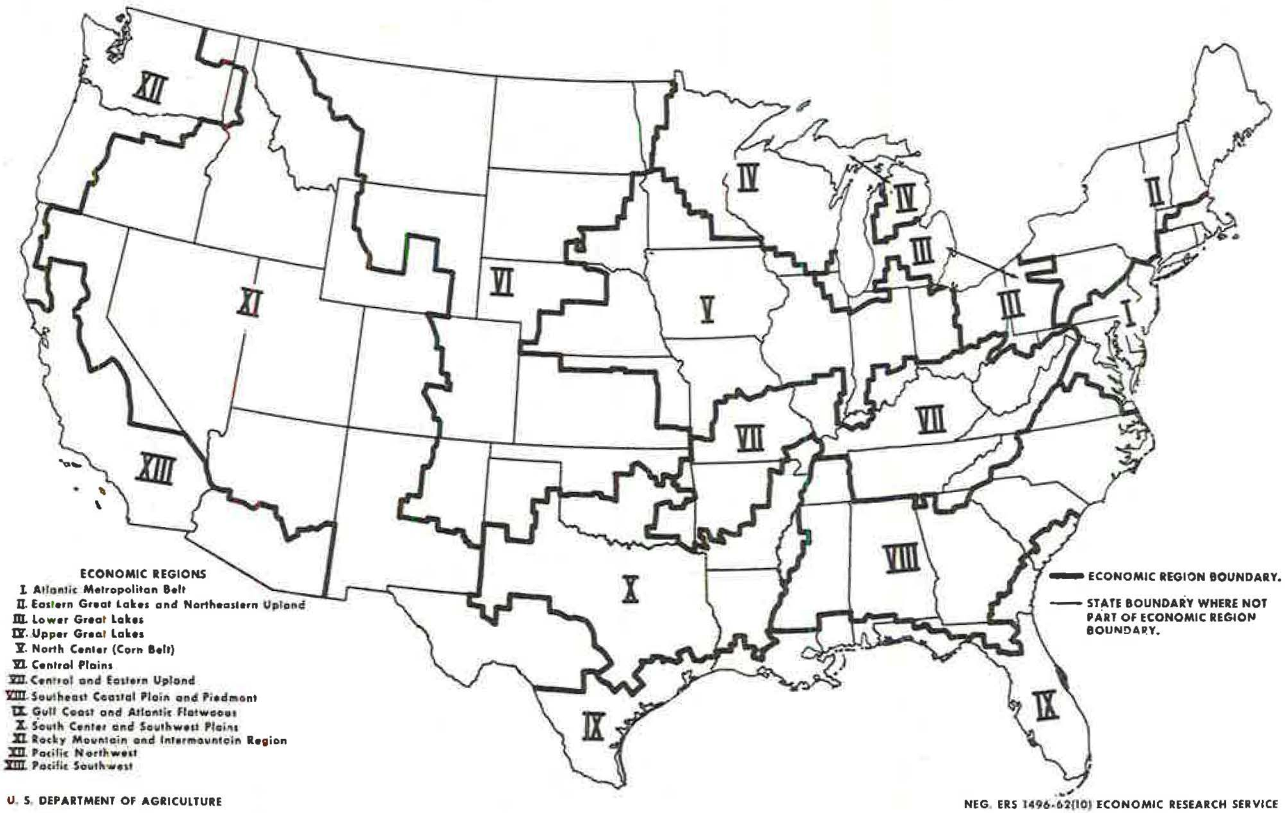

Figure 2. Economic regions of the United States.

TABLE 2

URBAN AND RURAL POPULATION OF THE UNITED STATES: 1790 TO 1960[a]

Area	Urban Definition	Census Date	Total: Population	Total: Increase over Preceding Census: Number	Total: Increase over Preceding Census: Percent	Urban: Population	Urban: Increase over Preceding Census: Number	Urban: Increase over Preceding Census: Percent	Rural: Population	Rural: Increase over Preceding Census[b]: Number	Rural: Increase over Preceding Census[b]: Percent	Percent of Total: Urban	Percent of Total: Rural
United States	Current	1960	179,323,175	27,997,377	18.5	125,268,750	28,421,933	29.3	54,054,425	-424,556	-0.8	69.9	30.1
		1950	151,325,798	-	-	96,846,817	-	-	54,478,981	-	-	64.0	36.0
	Previous	1960	179,323,175	27,997,377	18.5	113,056,353	22,928,159	25.4	66,266,822	5,069,218	8.3	63.0	37.0
		1950	151,325,798	19,161,229	14.5	90,128,194	15,422,856	20.6	61,197,604	3,738,373	6.5	59.6	40.4
		1940	132,164,569	8,961,945	7.3	74,705,338	5,544,739	8.0	57,459,231	3,417,206	6.3	56.5	43.5
		1930	123,202,624	17,181,087	16.2	69,160,599	14,907,317	27.5	54,042,025	2,273,770	4.4	56.1	43.9
Conterminous United States	Current	1960	178,464,236	27,766,875	18.4	124,699,022	28,231,336	29.3	53,765,214	-464,461	-0.9	69.9	30.1
		1950	150,697,361	-	-	96,467,686	-	-	54,229,675	-	-	64.0	36.0
	Previous	1960	178,464,236	27,766,875	18.4	112,531,941	22,782,878	25.4	65,932,295	4,983,997	8.2	63.1	36.9
		1950	150,697,361	19,028,086	14.5	89,749,063[c]	15,325,361	20.6	60,948,298[c]	3,702,725	6.5	59.6	40.4
		1940	131,669,275	8,894,229	7.2	74,423,702	5,468,879	7.9	57,245,573	3,425,350	6.4	56.5	43.5
		1930	122,775,046	17,064,426	16.1	68,954,823	14,796,850	27.3	53,820,223	2,267,576	4.4	56.2	43.8
		1920	105,710,620	13,738,354	14.9	54,157,973	12,159,041	29.0	51,552,647	1,579,313	3.2	51.2	48.8
		1910	91,972,266	15,977,691	21.0	41,998,932	11,839,011	39.3	49,973,334	4,138,680	9.0	45.7	54.3
		1900	75,994,575	13,046,861	20.7	30,159,921	8,053,656	36.4	45,834,654	4,993,205	12.2	39.7	60.3
		1890	62,947,714	12,791,931	25.5	22,106,265	7,976,530	56.5	40,841,449	4,815,401	13.4	35.1	64.9
		1880	50,155,783	11,597,412	30.1	14,129,735	4,227,374	42.7	36,026,048	7,370,038	25.7	28.2	71.8
		1870	38,558,371	7,115,050	22.6	9,902,361	3,685,843	59.3	28,656,010	3,429,207	13.6	25.7	74.3
		1860	31,443,321	8,251,445	35.6	6,216,518	2,672,802	75.4	25,226,803	5,578,643	28.4	19.8	80.2
		1850	23,191,876	6,122,423	35.9	3,543,716	1,698,661	92.1	19,648,160	4,423,762	29.1	15.3	84.7
		1840	17,069,453	4,203,433	32.7	1,845,055	717,808	63.7	15,224,398	3,485,625	29.7	10.8	89.2
		1830	12,866,020	3,227,567	33.5	1,127,247	433,992	62.6	11,738,773	2,793,575	31.2	8.8	91.2
		1820	9,638,453	2,398,572	33.1	693,255	167,796	31.9	8,945,198	2,230,776	33.2	7.2	92.8
		1810	7,239,881	1,931,398	36.4	525,459	203,088	63.0	6,714,422	1,728,310	34.7	7.3	92.7
		1800	5,308,483	1,379,269	35.1	322,371	120,716	59.9	4,986,112	1,258,553	33.8	6.1	93.9
		1790	3,929,214	-	-	201,655	-	-	3,727,559	-	-	5.1	94.9

[a] Source: U. S. Bureau of the Census, "1960 Census of Population." Series PC(1)-1A, Table 3.

[b] Minus sign denotes decrease.

[c] Revised since publication of 1950 reports.

TABLE 3

POPULATION IN GROUPS OF PLACES CLASSIFIED ACCORDING TO SIZE: 1960 AND 1950[a]

Type of Area	1960				1950				Percent Change in Population 1950 to 1960
	No. of Places	Population	Percent of Total Population	Percent of Total Area	No. of Places	Population	Percent of Total Population	Percent of Total Area	
Central Cities:									
1,000,000 or more	5	17,484,059	9.8	14.0	5	17,404,450	11.5	18.0	0.5
500,000 to 1,000,000	16	11,110,991	6.2	8.9	13	9,186,945	6.1	9.5	20.9
250,000 to 500,000	30	10,765,881	6.0	8.6	22	7,990,793	5.3	8.3	34.7
100,000 to 250,000	66	9,872,604	5.5	7.9	55	8,244,219	5.4	8.5	19.8
50,000 to 100,000	111	7,858,514	4.4	6.3	68	5,172,381	3.4	5.3	51.9
Under 50,000	26	883,083	0.5	0.7	9	378,452	0.3	0.4	133.3
Total	254	57,975,132	32.3	46.3	172	48,377,240	32.0	50.0	19.8
Urban fringes:									
2,500 or more:									
100,000 or more	15	1,779,822	1.0	1.4	11	1,485,210	1.0	1.5	19.8
50,000 to 100,000	90	5,977,388	3.3	4.8	37	2,562,230	1.7	2.6	133.3
25,000 to 50,000	212	7,253,877	4.0	5.8	71	2,494,662	1.6	2.6	190.8
10,000 to 25,000	518	8,209,099	4.6	6.6	231	3,629,308	2.4	3.7	126.2
5,000 to 10,000	399	2,862,099	1.6	2.3	268	1,892,680	1.3	2.0	51.2
2,500 to 5,000	346	1,250,219	0.7	1.0	241	885,800	0.6	0.9	41.1
Subtotal	1,580	27,332,504	15.2	21.8	859	12,949,890	8.6	13.4	111.1
Under 2,500:									
2,000 to 2,500	112	249,559	0.1	0.2	80	180,587	0.1	0.2	38.2
1,500 to 2,000	86	149,220	0.1	0.1	106	183,844	0.1	0.2	-18.8
1,000 to 1,500	122	152,177	0.1	0.1	93	115,660	0.1	0.1	31.6
Under 1,000	276	138,790	0.1	0.1	178	97,901	0.1	0.1	41.8
Subtotal	596	689,746	0.4	0.6	457	577,992	0.4	0.6	19.3
Other	---	9,851,105	5.5	7.9	---	7,344,026	4.9	7.6	34.1
Total	---	37,873,355	21.1	30.2	---	20,871,908	13.8	21.6	81.5
Within urbanized areas	---	95,848,487	53.5	76.5	---	69,249,148	45.8	71.5	38.4
Outside urbanized areas:									
25,000 or more	200	6,935,191	3.9	5.5	195	7,406,051	4.9	7.6	-6.4
10,000 to 25,000	610	9,237,648	5.2	7.4	548	8,248,451	5.5	8.5	12.0
5,000 to 10,000	995	6,917,615	3.9	5.5	916	6,299,956	4.2	6.5	9.8
2,500 to 5,000	1,806	6,329,809	3.5	5.1	1,617	5,643,211	3.7	5.8	12.2
Subtotal	3,611	29,420,263	16.4	23.5	3,276	27,597,669	18.2	28.5	6.6
Urban total	---[b]	125,268,750	69.9	100.0	---[c]	96,846,817	64.0	100.0	29.3
Rural:									
2,000 to 2,500	784	1,748,316	1.0	3.2	762	1,693,965	1.1	3.1	3.2
1,500 to 2,000	1,248	2,157,904	1.2	4.0	1,282	2,203,750	1.5	4.0	-2.1
1,000 to 1,500	2,119	2,590,568	1.4	4.8	2,142	2,617,759	1.7	4.8	-1.0
Subtotal	4,151	6,496,788	3.6	12.0	4,186	6,515,474	4.3	12.0	-0.3
Other	---	47,557,637	26.5	88.0	---	47,963,507	31.7	88.0	-0.8
Total	---	54,054,425	30.1	100.0	---	54,478,981	36.0	100.0	-0.8
United States, Total	---	179,323,175	100.0	---	---	151,325,798	100.0	---	18.5
Urbanized Areas:									
1,000,000 or more	16	51,785,410	28.9	54.0	12	37,817,068	25.0	54.6	36.9
500,000 to 1,000,000	22	15,365,801	8.6	16.0	13	8,751,241	5.8	12.6	75.6
250,000 to 500,000	30	10,624,125	5.9	11.1	24	8,676,270	5.7	12.5	22.5
100,000 to 250,000	85	13,480,252	7.5	14.1	70	10,888,119	7.2	15.7	23.8
Under 100,000	60	4,592,800	2.6	4.8	38	3,116,450	2.1	4.5	47.4
Total	213	95,848,487	53.5	100.0	157	69,249,148	45.8	100.0	38.4

[a]Source: U.S. Bureau of the Census, "1960 Census of Population." Series PC(1)-1A, Table 5.
[b]There were 5,445 places of 2,500 or more.
[c]There were 4,307 places of 2,500 or more.

TABLE 4

POPULATION AND DENSITY IN GROUPS OF PLACES CLASSIFIED ACCORDING TO SIZE: 1960[a]

Area	Population	Land Area (sq mi)	Population (per sq mi of land area)
United States:			
Places of 1,000,000 or more	17,484,059	1,261	13,865
500,000 to 1,000,000	11,110,991	1,888	5,885
250,000 to 500,000	10,765,881	2,401	4,484
100,000 to 250,000	11,652,426	2,728	4,271
50,000 to 100,000	13,835,902	3,539	3,910
25,000 to 50,000	14,950,612	5,319	2,811
10,000 to 25,000	17,568,286	6,939	2,532
5,000 to 10,000	9,779,714	5,005	1,954
2,500 to 5,000	7,580,028	5,242	1,446
Other urban territory	10,540,851	5,917	1,781
Rural territory	54,054,425	3,508,736	15
Total	179,323,175	3,548,974	51
Within urbanized areas:			
Places of 1,000,000 or more	17,484,059	1,261	13,865
500,000 to 1,000,000	11,110,991	1,888	5,885
250,000 to 500,000	10,765,881	2,401	4,484
100,000 to 250,000	11,652,426	2,728	4,271
50,000 to 100,000	13,835,902	3,539	3,910
25,000 to 50,000	8,015,421	2,594	3,090
10,000 to 25,000	8,330,638	2,873	2,900
5,000 to 10,000	2,862,099	1,488	1,923
2,500 to 5,000	1,250,219	856	1,461
Other urban territory	10,540,851	5,917	1,781
Total	95,848,487	25,544	3,752
Outside urbanized areas:			
Places of 25,000 to 50,000	6,935,191	2,725	2,545
10,000 to 25,000	9,237,648	4,066	2,272
5,000 to 10,000	6,917,615	3,517	1,967
2,500 to 5,000	6,329,809	4,386	1,443
Rural territory	54,054,425	3,508,736	15
Total	83,474,688	3,523,430	24

[a]Source: U.S. Bureau of the Census, "1960 Census of Population," Series PC(1)-1A, Table E.

TABLE 5

POPULATION INSIDE AND OUTSIDE CENTRAL CITY OR CITIES OF STANDARD METROPOLITAN STATISTICAL AREAS WITH POPULATION OF AREAS ANNEXED TO CENTRAL CITIES, BY REGIONS: 1960 AND 1950[a]

Region	Component Part of SMSA	Population		Change, 1950 to 1960						1960 Population on Basis of 1950 Limits of Central Cities
				Total		Based on 1950 Limits of Central Cities		From Annexations		
		1960	1950	Number	Per-cent	Number	Per-cent	Number	Per-cent	
United States	Central city	58,004,334	52,371,379	5,632,955	10.8	767,209	1.5	4,851,483	9.3	53,138,588
	Outside central city	54,880,844	36,945,524	17,935,320	48.5	22,801,066	61.7	-4,851,483	-13.1	59,746,590
	Total	112,885,178	89,316,903	23,568,275	26.4	23,568,275	26.4	--	--	112,885,178
Northeast	Central city	17,321,731	17,881,490	-559,759	-3.1	-594,078	-3.3	20,115	0.1	17,287,412
	Outside central city	18,024,774	13,385,679	4,639,095	34.7	4,673,414	35.0	-20,115	-0.2	18,059,093
	Total	35,346,505	31,267,169	4,079,336	13.0	4,079,336	13.0	--	--	35,346,505
North Central	Central city	16,510,746	15,836,656	674,090	4.3	-257,583	-1.6	931,673	5.9	15,579,073
	Outside central city	14,449,215	9,238,018	5,211,197	56.4	6,142,870	66.5	-931,673	-10.1	15,380,888
	Total	30,959,961	25,074,674	5,885,287	23.5	5,885,287	23.5	--	--	30,959,961
South	Central city	15,061,777	11,720,843	3,340,934	28.5	615,801	5.3	2,725,133	23.3	12,336,644
	Outside central city	11,385,618	7,696,908	3,688,710	47.9	6,413,843	83.3	-2,725,133	-35.4	14,110,751
	Total	26,447,395	19,417,751	7,029,644	36.2	7,029,644	36.2	--	--	26,447,395
West	Central city	9,110,080	6,932,390	2,177,690	31.4	1,003,069	14.5	1,174,562	16.9	7,935,459
	Outside central city	11,021,237	6,624,919	4,396,318	66.4	5,579,939	84.1	-1,174,562	-17.7	12,195,858
	Total	20,131,317	13,557,309	6,574,008	48.5	6,574,008	48.5	--	--	20,131,317

[a]Source: Adapted from U.S. Bureau of the Census, "1960 Census of Population" Vol. 1, Part A, Number of Inhabitants, Table P.

Table 3 shows that, as the resultant of all these factors, every size-class of urbanized area grew more rapidly than the total population, as did most size-classes of central cities and of places in the urban fringe. In contrast, all urban size-classes outside urbanized areas and all rural size-classes grew less rapidly than the national average or even had a decrease of population.

Analytically, however, it is useful to know how much of the growth in, say, a given place or class of places occurred within constant boundaries. Elsewhere it is estimated that 59 percent of the 1950-1960 increase in the urban population is attributable to reclassification of territory (2). Probably less than one-half of that is specifically attributable to annexations to incorporated places.

Population growth leads to greater population density unless the area is expanded to include more thinly settled territory. Within the fixed area of the 48 States, population density increased during the 1950's from 50.7 to 60.1 per square mile; but the addition of Alaska and Hawaii drove the density of the United States as defined in 1960 down slightly from the 1950 figure to 50.5. Obviously, this average density represents a very wide range among various areas even within the conterminous United States. Table 4 shows, for example, that urbanized areas had an average population of 3,752 per square mile, whereas that of rural territory was only 15. Within urbanized areas, the urban fringe areas, which are essentially suburban, had a density of 2,575 as contrasted with 5,349 for the central cities. Union City (40,138 persons per square mile) and two other cities in northeastern New Jersey have a higher density than New York City as a whole, but the Borough of Manhattan exceeds them with its density of 77,195. At the other extreme, some middle-sized cities (25,000 inhabitants or more) have relatively low densities. Examples are Hilo, Hawaii, with only 89; Oak Ridge, Tenn., with 316; and Concord, N.H., with 452.

At the risk of confusing the reader with still another type of area, it is necessary to discuss briefly the important concept of the metropolitan area. As defined by the Bureau of the Budget, a Standard Metropolitan Statistical Area (SMSA) includes a central city (or cities), the county containing it, and any contiguous counties that qualify in terms of criteria of metropolitan character and economic and social integration (3). The chief indicator used in determining the extent of integration is the rate of commuting by workers. Like urbanized areas, SMSA's have been defined for cities of 50,000 or more. An SMSA is almost always a larger area than its corresponding urbanized area, and the part beyond the urban fringe is of lower density. In fact, this density is only about 60, or not much above the national average of 51. Nevertheless, it is in this outer ring that the most rapidly growing areas of the next decade are likely to be found.

In 1960, 63 percent of all Americans lived in the 212 SMSA's. Central cities contained 32 percent and the metropolitan rings (including urban fringes) contained the remaining 31 percent. Although the central cities retain this slight majority of all metropolitan residents, the rates of growth in the 1950's show that their outlying areas are fast catching up (Table 5). The intercensal rates of growth are compared in Table 6. In fact, about five-sixths of the total national growth occurred within metropolitan areas and about two-thirds occurred within their outlying rings.

Moreover, 86 percent of the growth of the central cities was attributable to their annexations from their metropolitan rings. Had it not been for these numerous and extensive annexations during the decade, the rate of increase of central-city population would have been only 1.5 percent, whereas that of their rings would have been 62 percent. Nine of the 10 largest cities in 1950 and 19 of the 41 cities of 250,000 inhabitants or more in 1950 lost population as the

TABLE 6

INTERCENSAL RATES OF GROWTH

Total	Rate of Growth[a](%)
U.S.	18.5
SMSA	26.4
Central cities	10.8
Rings	48.5

[a]Of 1950 population.

result of net out-migration. Essentially, these net losses were to the city's own suburbs. Only 8 of 212 entire metropolitan areas lost population during the 1950's. These were areas of chronic economic depression like the Johnstown, Scranton, Wheeling, and Wilkes-Barre—Hazleton SMSA's. The decline of coal mining was frequently a factor.

An interesting analysis of population change could be made in terms of small areas like city blocks, census tracts, and the minor civil divisions (townships, etc.) of counties. This would bring out the effects of new subdivisions and shopping centers; urban renewal and redevelopment; freeway construction; the creation of artificial lakes by damming rivers; the opening or expansion of factories, research laboratories, office buildings, and military posts and the contraction or closing down of such installations; and other ways in which man is altering the surface of this continent. This picture is too detailed to be painted on the small canvas of this paper, but many intensive local studies are being made and published.

The important role of net migration in redistributing population has been mentioned. Much of population movement is compensating, however, so that gross migration considerably exceeds the sum of net shifts; for example, when from the 1950 Census statistics the sum of the net migration in the preceding year for all States and net in-migration is about 300,000. The total number of interstate migrants in this same 1949-50 period was 3.9 million, however. There is some evidence that the ratio of net migration to gross migration is declining; i.e., that a larger share of the gross migration is compensating (4).

About one in five Americans changes his address in any given year. This rate represents about 36 million persons nowadays, of whom 11 million move to a different county and 6 million to a different State. An estimated 8 or 9 million families have moved in each recent year. Many, if not most, of these movers use automobiles and moving vans to transport themselves and their furniture, respectively, to their new homes.

But obviously most passenger car trips are not made for the purpose of effecting a change of usual residence. Various origin and destination studies give a partial picture of the purposes of automobile trips and the relative numbers of passengers who are going to work, to school, to shop, and so on. There are no comprehensive national statistics with a classification by routes, areas, time of day, day of the week, or season of the year. A new set of statistics that is comprehensive in at least its national coverage is becoming available from the 1960 Census, however. (Furthermore, the 1963 Census of Transportation will include a National Travel Survey, which will collect data quarterly from a panel of households concerning (a) trips over-night or to a place at least 100 miles away, and (b) home-to-work travel.)

The 1960 Census had questions on place of work in the preceding week and on the chief means of transportation employed. These questions and the resulting tabulations represent a modest beginning in some respects. The geographic detail on place of work is not so great as one would like, and all means of transportation used in the given week are not known. Nonetheless, a large volume of statistics (some in unpublished form) is becoming available. These show considerable detail on place of residence and on the characteristics (age, sex, occupation, industry, etc.) of the commuters.

Some summary figures are given in Tables 7 and 8. In the country as a whole, of those workers reporting, about one in seven worked away from their county of residence. There are, of course, tremendous geographic variations in this kind of commuter rate; but, surprisingly, the rate for workers living in metropolitan areas is only a little higher than that for those in nonmetropolitan areas. The moderate over-all metropolitan rate results from the fact that relatively few of the many workers in central cities of SMSA's work outside their home county. Between one-fifth and one-fourth of workers living in urban-fringe areas, however, commute to a different county. In Fairfax County, Va. (a Washington "bedroom" county), 64 percent of those reporting worked outside the county and 38 percent worked in Washington. In the outlying "rings" of SMSA's of 100,000 or more, 34 percent of the workers reporting worked in the central city, whereas, of those living in the central cities, only 10 percent commuted to the outlying rings (Table 9).

If any proof is needed of the overwhelming importance of the private automobile as

TABLE 7

PLACE OF WORK OF WORKERS[a] DURING THE CENSUS WEEK, BY COLOR, FOR THE UNITED STATES, URBAN AND RURAL: 1960[b]

Worker	Place of Work	Number: United States	Number: Urban	Number: Rural Nonfarm	Number: Rural Farm	Percent Distribution: United States	Percent Distribution: Urban	Percent Distribution: Rural Nonfarm	Percent Distribution: Rural Farm
White	In county of res.	47,312,465	34,263,368	9,435,743	3,613,354	81.4	81.5	79.3	87.1
	Outside county of res.	8,423,028	5,990,983	2,039,283	392,762	14.5	14.2	17.1	9.5
	Not reported	2,363,993	1,789,647	429,638	144,708	4.1	4.3	3.6	3.5
	Subtotal	58,099,486	42,043,998	11,904,664	4,150,824	100.0	100.0	100.0	100.0
Nonwhite	In county of res.	5,499,552	4,279,407	867,172	352,973	83.9	83.6	83.4	89.5
	Outside county of res.	562,560	412,850	124,804	24,906	8.6	8.1	12.0	6.3
	Not reported	494,207	429,493	48,312	16,402	7.5	8.4	4.6	4.2
	Subtotal	6,556,319	5,121,750	1,040,288	394,281	100.0	100.0	100.0	100.0
Total	In county of res.	52,812,017	38,542,775	10,302,915	3,966,327	81.7	81.7	79.6	87.3
	Outside county of res.	8,985,588	6,403,833	2,164,087	417,668	13.9	13.6	16.7	9.2
	Not reported	2,858,200	2,219,140	477,950	161,110	4.4	4.7	3.7	3.5
	Subtotal	64,655,805	47,165,748	12,944,952	4,545,105	100.0	100.0	100.0	100.0

[a]Including members of Armed Forces.
[b]Source: U. S. Bureau of the Census, "1960 Census of Population." Series PC(1)-1C, Table 93.

TABLE 8

MEANS OF TRANSPORTATION TO WORK OF WORKERS[a] DURING THE CENSUS WEEK, FOR THE UNITED STATES, URBAN AND RURAL: 1960[b]

Means of Transportation to Work	Number: United States	Number: Urban	Number: Rural Nonfarm	Number: Rural Farm	Percent Distribution: United States	Percent Distribution: Urban	Percent Distribution: Rural Nonfarm	Percent Distribution: Rural Farm
Private automobile or car pool	41,368,062	30,295,829	9,390,246	1,681,987	64.0	64.2	72.5	37.0
Railroad, subway, or elevated	2,484,281	2,436,865	44,657	2,759	3.8	5.2	0.3	0.1
Bus or streetcar	5,322,651	5,142,633	158,948	21,070	8.2	10.9	1.2	0.5
Walked to work	6,416,343	4,717,841	1,435,783	262,719	9.9	10.0	11.1	5.8
Other means	1,619,842	1,029,471	471,227	119,144	2.5	2.2	3.6	2.6
Worked at home	4,662,750	1,357,400	991,701	2,313,649	7.2	2.9	7.7	50.9
Not reported	2,781,876	2,185,709	452,390	143,777	4.3	4.6	3.5	3.2
Total worker	64,655,805	47,165,748	12,944,952	4,545,105	100.0	100.0	100.0	100.0

[a]Including members of Armed Forces.
[b]Source: U.S. Bureau of the Census, "1960 Census of Population," Series PC(1)-1C, Table 94.

a means of getting people to work, Table 8 should provide it. Nationally, two-thirds of all workers used a car as their chief means of traveling between home and work. Less than one-tenth used a bus or streetcar and another 4 percent used other forms of public transportation (railroad, subway, or elevated train). For workers living in the central cities of SMSA's, of course, public transportation is relatively more important. Even there, however, only 27 percent reported this means, or about one-half the proportion reporting private automobile or carpool. Only in New York City do more than one-half of the workers use public transportation.

If commuter streams between certain areas and types of areas, are considered additional contrasts are found. Within SMSA's of 100,000 or more, 82 percent of those commuting to the central city used a private automobile or carpool, whereas this means was reported by a bare majority (54 percent) of those both living and working in the central city. Of those living and working in New York City, 18 percent traveled by automobile, 53 percent by subway, and 15 percent by bus; whereas of those commuting from the New York metropolitan ring (that part in New York State only), 43 percent used an automobile, 54 percent, railroad or subway, and only 2 percent traveled by bus.

A few students in the United States and Western Europe have speculated that the rise

TABLE 9

PLACE OF WORK AND MEANS OF TRANSPORTATION OF WORKERS DURING THE CENSUS WEEK, BY RESIDENCE IN THE CENTRAL CITY OR IN THE RING, FOR STANDARD METROPOLITAN STATISTICAL AREAS OF 100,000 OR MORE: 1960[a]

Residence and Means of Transportation	Total Workers 14 Years or Over	Place of Work			
		Central City	SMSA Ring	Outside SMSA of Residence	Not Reported
Living in central city of SMSA	22,134,421	18,301,306	2,027,946	537,127	1,268,042
Total reporting means of transportation	20,823,578	18,142,360	2,006,086	524,756	150,376
Percent distribution:					
Private automobile or carpool	57.9	54.4	84.9	74.5	59.5
Railroad, subway, or elevated	9.3	10.1	1.7	9.5	9.6
Bus or streetcar	18.4	19.6	10.5	7.3	18.2
Walked only	9.9	11.0	1.5	2.9	7.3
Other means	1.7	1.6	1.4	5.7	5.4
Worked at home	2.8	3.3	--	--	--
Not reporting	1,310,843	158,946	21,860	12,371	1,117,666
Living in SMSA ring	19,642,613	6,491,160	11,324,847	1,073,708	752,898
Total reporting means of transportation	18,784,183	6,329,531	11,225,396	1,058,280	170,976
Percent distribution:					
Private automobile or carpool	77.1	82.3	74.0	79.0	78.0
Railroad, subway, or elevated	2.7	6.1	0.3	6.9	4.8
Bus or streetcar	6.1	8.9	4.3	7.8	6.3
Walked only	7.6	1.3	11.7	1.7	5.4
Other means	2.3	1.3	2.5	4.5	5.5
Worked at home	4.3	--	7.2	--	--
Not reporting	858,430	161,629	99,451	15,428	581,922

[a]Source: Adapted from U.S. Bureau of the Census, "1960 Census of Population." Series PC(1)-1D, Table 216 (forthcoming report).

of worker-commuting has tended to reduce the amount of migration into the growing labor markets and have tried to measure the relationship between these two types of movement (5, 6). The relationship is probably more complex than this statement suggests, however. Not only might workers living on the periphery of a labor market decide to commute daily rather than to move into town but also workers who live in the central city may decide to move their homes to this same peripheral area because of the feasibility of commuting. Moreover, shopping centers and other service facilities are diffusing to the periphery, and some employers are locating there to tap the local labor supply and to use other advantages of a site outside the city proper.

The fact that the Census statistics will show the streams of workers commuting to and from the larger areas permits the estimation of the total number of workers employed in the area, or in other words, the daytime working population. Such estimates have already been published on a limited basis (7).

What of the future? Will these trends intensify, will they level off in plateaus, or will some strong countertrends develop? Officially, the Bureau of the Census makes projections on the basis of specified assumptions. It does not make predictions or forecasts.

The last published projections to 1975 of the total population show 226 or 235 million, depending on the assumption about future births. Either may be too high or too low; but, barring some major catastrophe, a population of 200 million is not very far off. There are 188 million today including the Armed Forces abroad.

Others have speculated about future trends in the metropolitan population and in the urban population. Writing in 1957, Cuzzort and Siegel independently concluded that there would be further concentration of the population in metropolitan areas and Siegel added, in urban areas and in suburbs, as well (8, 9). Cuzzort projected the proportion of the population in SMSA's of 100,000 or more from 56 percent in 1950 to 60 or 66 percent in 1975. The percentage observed in 1960 was already 63. The higher percentage, namely 66, looks somewhat more likely, therefore. Applied to the total population projections already cited, this yields a population of roughly 150 million in the principal metropolitan areas only a dozen years ahead. In a recent paper, Beale has speculated about the future growth of the rural population (10). By subtraction, the projected urban population would constitute about 74 percent of the total in 1970 and 78 percent in 1980, as compared with 70 percent in 1960.

There is little doubt that these kinds of population concentrations are going to persist for several decades, partly because of the continuing decline in the number of families dependent on agriculture or mining. What is perhaps more problematical is whether the flight to the suburbs will be slowed down or even reversed, and people will be more attracted by the conveniences and amenities of the city proper. Already, some observers profess to see signs of a slackening of the centrifugal movement (11). These straws in the wind seem to have had very little impact on the statistics, however. One may have to wait until the next census to see whether big cities have recovered their losses of the 1950's or whether the decentralization pattern that was most pronounced in large metropolitan areas of the Northeast will spread to other regions and to smaller SMSA's.

Schnore expects commuting in 1975 to be characterized by a greater amount of lateral movement around the city, further decentralization of population, even longer work-trips, and more use of the private automobile (12). Writing in the same symposium, Hitchcock of the Bureau of Public Roads projected motor-vehicle registrations and highway travel to 1975 (13). In comparison with the 1960 figures that have since become available, these projections imply considerably higher rates of increase for vehicle registrations and highway travel over the 15-year period than those projected for population. These relative growth rates are, of course, in line with past trends. Moreover, most projections assume the continuation of past trends. One of the great values of projections, however, is to give leaders an opportunity to see the indicated results, to compare these results with a preferred set of attainable living conditions, and to make necessary plans or suggestions for changing the trends. There may be differences about national goals, but there is agreement on the need for better data for plotting the course and for understanding the complex cause-and-effect relationships that were mentioned at the beginning of this paper.

ACKNOWLEDGMENT

The writer wishes to acknowledge the assistance of Elizabeth Larmon in the preparation of this paper.

REFERENCES

1. Bogue, D. J., and Beale, C. L., "Economic Areas of the United States." Free Press, Glencoe (1961).
2. Shryock, H. S., Jr., "Some Results of the 1960 Census of the United States." Rural Sociol., 27:460-472 (Dec. 1962).
3. "Standard Metropolitan Statistical Areas." U.S. Bureau of the Budget (1961).
4. Shryock, H. S., Jr., "The Efficiency of Internal Migration in the United States." Internat. Union for the Scientific Study of Population, Internat. Population Conf., Vienna (1959).
5. Horstmann, K., "Internal Migration in the Federal Republic of Germany." Proc., World Population Conf., 1954 (Rome), Vol. 2, United Nations, New York (1955).
6. Belcher, J. C., "Commuting: A Functional Alternative to Migration." Paper, Rural Sociol. Soc., Washington, D.C. (Aug. 1962).
7. "Day-Time Population of Large Cities." Metropolitan Life Insurance Co. Statis. Bull., 43:4-6 (Sept. 1962).
8. Cuzzort, R. P., "The Size and Distribution of Standard Metropolitan Areas." In D. J. Bogue (Ed.), "Applications of Demography: The Population Situation in the U.S. in 1975." Scripps Found. for Res. in Population Problems, pp. 62-67 (1957).
9. Siegel, J. S., "Future Distribution of the Population of the United States by Regions and Type of Residence." In D. J. Bogue (Ed.), "Applications of Demography: The Population Situation in the U.S. in 1975." Scripps Found. for Res. in Population Problems, pp. 60-61 (1957).

10. Beale, C. L., "Current and Foreseeable Trends in Rural Population." Paper, Economic and Statistical Analysis Div., 40th Annual Agric. Outlook Conf., Washington, D. C. (Nov. 14, 1962).
11. Parrott, A. F., "The Flight to the Suburbs Slackens." Proc. Social Statistics Section 1960, Amer. Statistical Assoc., Washington, D. C., pp., 152-158 (1960).
12. Schnore, L. F., "The Journey to Work in 1975." In D. J. Bogue (Ed.), "Applications of Demography: The Population Situation in the U. S. in 1975." Scripps Found. for Res. in Population Problems, pp. 73-75 (1957).
13. Hitchcock, S. T., "Highway Traffic and Traffic Fatalities in 1957." In D. J. Bogue (Ed.), "Applications of Demography: The Population Situation in the U. S. in 1975." Scripps Found. for Res. in Population Problems, pp. 82-89 (1957).

Public Response to Increased Bus Service

ALBERT J. MAYER and SUE M. SMOCK, respectively, Director and Chief Research Analyst, Institute for Regional and Urban Studies, Wayne State University, Detroit, Michigan

•CONSTANTLY INCREASING automobile ownership, accompanied by increasing suburbanization of the population, has continued to jeopardize public transportation systems in nearly every city in the United States. Decreased patronage has forced economies in service and increased fares, which in turn have caused further patronage decreases. Thus, a degenerative cycle is set in motion. An example of this is in Detroit where the use of the city-owned bus system declined 44 percent between 1954 and 1960.

An experiment designed to break into this degenerative cycle was undertaken in April 1962 by the HHFA and the City of Detroit. The number of buses on one line was increased for a period of time to see if better service could retard the downward spiral. Obviously other factors (such as fare decreases, intensified service on transfer lines, and better equipment) play a part, but it is believed that the principal factor is increased service. The data, which will be reviewed later, supported this contention.

STUDY DESIGN

In April 1962, an experiment was conducted on one specific coach line of the Detroit public transit system. This line runs motor and electric buses for approximately 14 miles along a major diagonal arterial from the Detroit CBD to the city limits. For eight weeks the number of buses on the Grand River line was increased approximately 70 percent, spread over a 24-hour period through each day of the week.

To assess the effectiveness of this increased service, a sample of passengers on the Grand River line was interviewed before the increased service was put into effect, and again, after the additional buses were in operation. However, the true effect cannot be ascertained by interviewing riders only; therefore, sampled households located in the corridor served by this line were also interviewed during this experimental period. Furthermore, this was contrasted to the 1953 travel behavior of residents of this same corridor. The purpose of this household interview was to find out why non-riders remained non-riders in the face of increased service.

This paper, which reports on the results of the study to date, has two parts: the first concerns the Grand River bus passengers, and the second deals with the residents of the corridor serviced by this bus line. The complete reports are presented elsewhere (1).

RESULTS

Better service in the form of more buses did attract more riders to the Grand River line, but to a limited degree. The study showed a 1.6 percent increase on an average weekday, 6.0 percent increase on an average Saturday and 8.7 on Sunday (Tables 1 and 2). The over-all increase was 3 percent. [Results obtained from the Department of Streets and Traffic Study differed from these. This discrepancy has been attributed to the fact that in the latter study specific rather than average days were used. A further discussion of this comparison is given elsewhere (1, Report I).] This was the passenger "pay-off" resulting from a 70 percent addition in buses. The increase in service had a differential effect with regard to express and local buses. Local buses had only a 0.5 percent increase in patronage, whereas riders on the express buses increased 13.3 percent.

It can be concluded from the nature of the change that patronage increased mainly where it would do the least good from an operational and revenue point of view. That

Paper sponsored by Special Committee on Urban Transportation Research.

TABLE 1

NUMBER OF PASSENGERS AND PERCENT CHANGE BY TRIP DIRECTION FOR DAY OF TRAVEL: BEFORE AND AFTER INCREASED SERVICE

Trip Direction	Weekday			Saturday			Sunday		
	No. of Passengers		Percent Change	No. of Passengers		Percent Change	No. of Passengers		Percent Change
	Before Increase	After Increase		Before Increase	After Increase		Before Increase	After Increase	
Outbound	18,041	17,677	-2.0	10,749	11,128	+3.5	4,027	4,239	+5.3
Inbound	18,104	19,030	+5.1	10,527	11,421	+8.5	3,839	4,311	+12.3
Total	36,145	36,707	+1.6	21,276	22,549	+6.0	7,866	8,550	+8.7

is, the weekday local, the bulk of the service, was little affected. Express service, which showed the greatest increase, carried only about 10 percent of the weekday trips. Sunday service, which showed the next greatest increase, carried only about 12 percent of all trips. The experiment indicates that added patronage could be obtained by selected service increases concentrated on express buses, on Sunday, and to some extent on Saturday. Whether this is practical in terms of being worth the expense, is, of course, another question.

It should be emphasized that this was a pilot study of some eight weeks duration, and its limited feature was well understood. Changing travel habits take time, and if the increased service had been extended for a long period of time, perhaps further increases would have taken place. Patronage was higher at the end of the experiment than at the time of this study (2). Sunday service was then continued after the eight weeks but once again dropped off. This does not mean that the same effect would necessarily occur on weekdays.

Another aspect was that despite extensive publicity efforts only about one-half the population, bus riders and residents, knew of the service increase. It takes time for information of any change to diffuse to everyone, and if the experiment and the publicity had continued longer perhaps more riders would have been attracted.

A third inherent difficulty was that service was added only on the Grand River line, without a corresponding increase on other lines in the system. Of these bus trips 55 percent involved a transfer from another line (Table 3). To achieve any really positive results would doubtless mean increasing service over most, if not all, of the total public transportation system.

TABLE 2

NUMBER OF PASSENGERS AND PERCENT CHANGE ON AN AVERAGE WEEKDAY BY TRIP DIRECTION FOR TYPE OF BUS: BEFORE AND AFTER SERVICE INCREASE

Trip Direction	Total			Local			Express		
	No. of Passengers		Percent Change	No. of Passengers		Percent Change	No. of Passengers		Percent Change
	Before Increase	After Increase		Before Increase	After Increase		Before Increase	After Increase	
Outbound	18,041	17,677	-2.0	16,802	16,329	-2.8	1,239	1,348	+8.8
Inbound	18,104	19,030	+5.1	16,320	16,951	+3.9	1,784	2,079	+16.5
Total	36,145	36,707	+1.6	33,122	33,280	+0.5	3,023	3,427	+13.3

Although the passenger increases were small and there were a number of limitations, the Wayne State University project was very successful. It was, in fact, possible to board buses and obtain a good deal of reliable information about the passengers and their trips as well as travel behavior from the usual home interview. By analyzing these characteristics, inferences can be made about the possibilities for future experiments and possible changes in public transportation service.

TABLE 3

TRIPS BY TRANSFER PATTERN FOR TRIP DIRECTION: BEFORE AND AFTER INCREASED SERVICE

Transfer Pattern	Trips (%)					
	Before Increased Service			After Increased Service		
	Total	Outbound	Inbound	Total	Outbound	Inbound
No transfer	44.5	44.4	44.6	43.4	43.5	43.3
Transfer:						
To Grand River	25.8	21.8	29.6	26.7	22.7	30.3
From Grand River	22.4	26.3	18.7	21.7	25.5	18.2
To and from Grand River[a]	7.3	7.5	7.1	8.2	8.3	8.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

[a] Grand River bus is second of three buses these passengers are taking to complete trip; i.e., they are transferring both to and from Grand River bus.

TABLE 4

AREA OF RESIDENCE BY DAY OF TRAVEL: BEFORE AND AFTER INCREASED SERVICE

Area of Residence[a]	Trips (%)					
	Weekday		Saturday		Sunday	
	Before Increase	After Increase	Before Increase	After Increase	Before Increase	After Increase
Grand River corridor:						
Area 1	11.6	10.3	13.4	12.2	15.5	15.6
Area 2	14.5	15.4	17.2	18.5	19.5	18.2
Area 3	16.6	15.6	15.0	15.3	14.9	15.3
Area 4	12.1	12.0	9.1	7.5	6.6	7.5
Subtotal	54.8	53.3	54.7	53.5	56.5	56.6
Westside Detroit	26.9	29.9	29.4	31.1	24.0	25.7
Eastside Detroit	9.6	7.8	5.6	7.9	10.5	11.4
Outside Detroit	8.7	9.0	10.3	7.5	9.0	6.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

[a] Figure 1 shows area boundaries; Woodward Avenue separates westside Detroit from eastside Detroit.

BUS RIDERS BEFORE AND AFTER INCREASED SERVICE

The most obvious question is whether the "new" bus riders and the trips they made were similar to persons and trips that existed before the increase in service. At first glance it would seem that the most valid way to do this would be to identify "new" persons and compare them with the pre-existing populations of bus riders. However, this was technically unfeasible because less than 1 percent of the trips made after the service was increased were made by new bus riders. Instead, the discussion compares the total group of persons interviewed before and after the service was increased.

Residence

On the buses, trips rather than people were necessarily sampled. Therefore, the same persons could be interviewed more than once. Thus when personal characteristics are referred to, actually they are not descriptions of unique people but are person characteristics of the trips. In this context trips and persons (passengers) are synonymous.

To view a bus line as servicing only those persons who live relatively nearby may be erroneous. As a matter of fact, 9 percent of the trips on the Grand River line were made by persons living outside the city limits (Table 4). On the other hand, about one-half of the trips were made by persons living in the Grand River corridor (Fig. 1). There was no significant change in residence after the service was increased.

Sex and Race

Women used this bus more often than men, and whites more often than non-whites. Again, there was no change after the service was increased (Table 5).

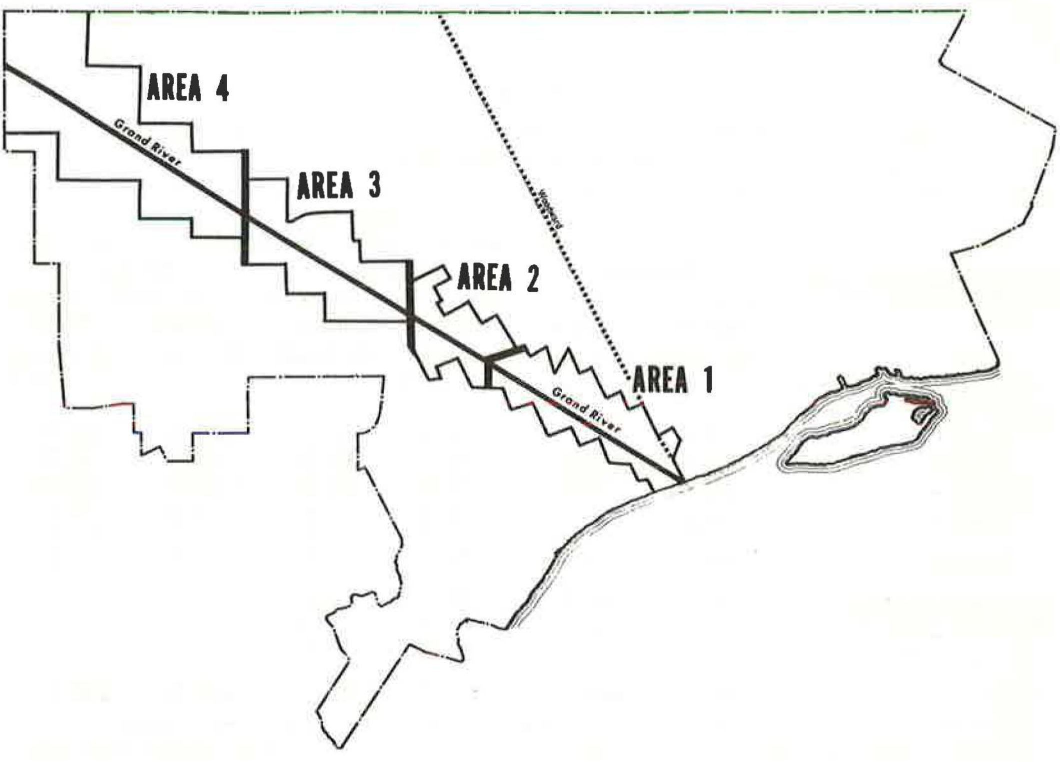

Figure 1. Grand River corridor, City of Detroit, 1962.

Occupation

Although the majority of trips were made by females, housewives constituted only 15 percent of the tripmakers (Table 6). The 36 percent in blue collar occupations was rather large considering the fact that the Grand River bus is not a "factory" line.

TABLE 5

SEX AND RACE FOR DAY OF TRAVEL: BEFORE AND AFTER INCREASED SERVICE

Sex and Race	Trips (%)					
	Weekday		Saturday		Sunday	
	Before Increase	After Increase	Before Increase	After Increase	Before Increase	After Increase
Male	38.6	39.2	40.3	38.4	52.0	51.6
Female	61.4	60.8	59.7	61.6	48.0	48.4
White	63.9	64.5	59.3	57.9	57.3	60.0
Negro	35.3	34.9	39.9	41.5	41.2	39.7
Other and unknown	0.8	0.6	0.8	0.6	1.5	0.3

TABLE 6

PERCENTAGE DISTRIBUTION OF TRIPS BY PASSENGER'S OCCUPATION BEFORE AND AFTER INCREASED SERVICE

Occupation	Trips (%)	
	Before Service Increase	After Service Increase
Employed:		
Professional and technical	5.0	4.3
Managers, officials and proprietors	2.1	2.5
Clerical and sales	18.4	18.0
Craftsmen and foremen	7.1	6.1
Operatives	7.2	6.3
Laborers	8.1	10.6
Service workers (including armed forces)	13.4	13.7
Not otherwise classified	0.7	0.4
Total	62.0	61.9
Not Employed:		
Unemployed	2.2	2.7
Retired	4.2	3.9
Housewives	15.4	14.7
Students [a]	16.2	16.8
Total	38.0	38.1

[a] In April study, 14.6 percent of total students were also employed; in May, 22.0 percent of total students were also employed.

That is, it gives no direct access to the larger manufacturing plants in the area. However, this is understandable when it is recalled that 55 percent of these passengers transferred to other bus lines. On the other hand, this bus does offer direct access to highly developed commercial areas. Therefore, a higher proportion of white collar workers might be expected.

There were substantial differences in occupation between the Sunday riders and the riders of the two other days. Also, in both white and blue collar groups, the most prevalent occupations were those of lower socio-economic status. This same general distribution existed after the increased service.

Trip Purpose

Changes in service made little difference in trip purpose. When home trips were eliminated, work was the principal trip purpose, accounting for one-half the trips. (Even on Sunday, over 20 percent of the trips were to work.) Although this is a CBD-oriented bus, one-third of the trips to work used the outbound bus. The importance of the various trip purposes changed depending on day of travel (Table 7).

However, because Easter Sunday occurred just before the second interview period, there was a decrease in shopping trips. This points to another limitation of this pilot study. Certainly more precise control data should be collected to indicate variations that are attributed to factors other than that being tested.

Origin and Destination

Although the distribution of transfers, residence, and trip purposes remained much the same, the origins and destinations of trips showed a change after the service was increased. There was an increase in trips coming from both the CBD and the suburbs (Table 8). Furthermore, on Saturday and Sunday there was also a change in trips from that part of Detroit outside the Grand River subcommunities. (Subcommunities

TABLE 7

TRIP PURPOSE FOR DAY OF TRAVEL BEFORE AND AFTER INCREASED SERVICE

Trips Purpose[a]	Trips (%)					
	Weekday		Saturday		Sunday	
	Before Increase	After Increase	Before Increase	After Increase	Before Increase	After Increase
Work	47.5	49.1	34.0	35.9	23.8	21.8
Shopping	13.9	14.8	32.8	25.7	5.5	1.8
Personal business	12.8	12.1	9.5	10.5	0.6	3.3
School	12.1	12.3	0.9	1.9	0.4	0.6
Social[b]	6.9	6.1	13.0	16.2	29.0	27.5
Recreation	3.3	2.9	5.4	5.5	14.2	16.2
Church	1.2	0.7	2.9	2.3	21.8	25.5
Serve passenger	0.6	0.3	0.4	0.3	0.7	1.0
Eat meal	0.4	0.9	0.8	0.8	3.1	2.0
Unknown	1.3	0.8	0.3	0.9	0.9	0.3

[a] Exclusive of trips to home.
[b] Those leisure trips whose destination is a private residence; in contrast, recreation trips are leisure trips whose destination is a commercial establishment.

TABLE 8

TRIP ORIGINS AND DESTINATIONS AND PERCENT CHANGE FOR DAY OF TRAVEL: BEFORE AND AFTER INCREASED SERVICE

Trip Origins and Destinations	Weekday			Saturday			Sunday		
	No. of Passengers		Percent Change	No. of Passengers		Percent Change	No. of Passengers		Percent Change
	Before Increase	After Increase		Before Increase	After Increase		Before Increase	After Increase	
Origins:									
Central business district	6,072	8,002	+31.7	3,702	4,104	+10.8	834	1,197	+43.6
Grand River subcommunities [a]	20,603	19,271	-6.5	12,574	12,560	-0.1	4,633	4,899	+5.8
Remainder of Detroit	7,265	6,937	-4.5	3,468	4,171	+20.3	1,888	1,650	-12.6
Outside of Detroit	2,205	2,496	+13.2	1,532	1,714	+11.9	511	804	+57.2
Total	36,145	36,706	+1.6	21,276	22,549	+6.0	7,866	8,550	+8.7
Destinations:									
Central business district	6,795	6,827	+0.5	4,255	4,262	+0.2	1,161	1,009	-15.1
Grand River subcommunities [a]	19,988	20,592	+3.0	12,362	12,943	+4.7	4,763	4,805	+0.9
Remainder of Detroit	7,193	6,680	-7.1	3,319	3,653	+10.1	1,572	2,206	+40.3
Outside of Detroit	2,169	2,606	+20.2	1,340	1,691	+26.2	370	530	+43.4
Total	36,145	36,706	+1.6	21,276	22,549	+6.0	7,866	8,550	+8.7

[a] Except CBD.

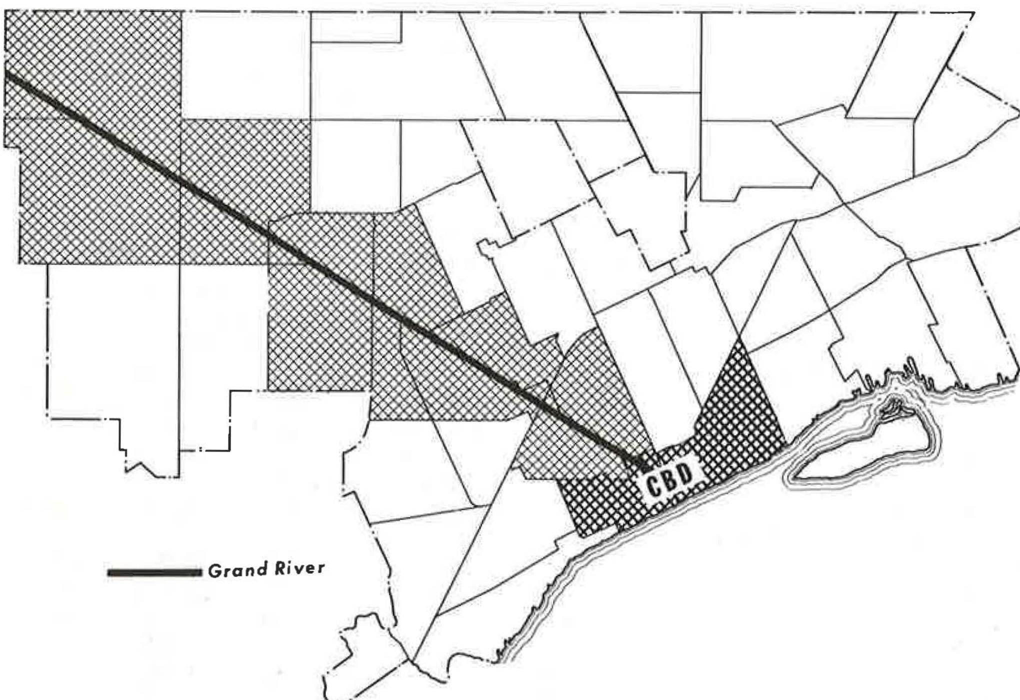

Figure 2. Grand River subcommunities, City of Detroit, 1962.

are relatively homogeneous groupings of census tracts.) The trip destinations showed little change except for an increase in trips going outside the city.

Perhaps the most curious change occurred in the weekday trip pattern where the CBD, as an origin, increased over 30 percent, but as a destination not at all. It appears that this increase was partially due to factors unrelated to this experiment. On the other hand, some of this may be due to a slight increase in trips from work. This is substantiated to some extent by the fact that there was an increase in the proportion of employed people who used the bus both to and from work after the service increased. Compensating for this, there was a decrease in workers who only used the bus one way.

Express Passengers

The express passenger was very different from the typical bus passenger. For example, although only 3 percent of the local passengers were in professional and managerial occupations, this was true of 14 percent of the express passengers. In fact, only 8.7 percent were nonemployed as compared to 42 percent of the local passengers. The express bus was used almost exclusively for one purpose: 91 percent of the passengers were going to and from work.

Yet the express bus exhibited the largest percent of increase (13.3 percent). Unlike the other buses, there was a change in the type of person using the express bus. The percent of housewives and students increased and this was reflected in a change in trip purpose. It must be remembered, however, that this change is almost meaningless as a part of the total trips because on an average day this 13 percent increase amounted to only 404 actual passengers.

Suggestions for Improving Public Transit

Bus riders were asked both before and after the service increase what suggestions they had for improving public transit. The purpose of this question was to see if the increased service had met with the approval of the patrons, and if they had further unmet needs. Table 9 shows that after the service was increased, there was greater satisfaction with transit service in general (from 9 to 14 percent) and with the Grand River line in particular (from 14 to 24 percent). Before the experiment almost one-third of the passengers suggested an increase in service. After the actual service change, there was still one out of six who wanted further increases.

TABLE 9

SUGGESTIONS FOR IMPROVING BUS SERVICE: BEFORE AND AFTER INCREASED SERVICE

Type of Suggestion	Percent of Suggestions		Number of Suggestions		Percent Change
	Before Increase	After Increase	Before Increase	After Increase	
No suggestions	30.2	29.1	19,827	19,736	-0.5
General satisfaction	8.8	13.5	5,777	9,156	+58.5
Satisfaction with Grand River and dissatisfaction with other lines	13.5	23.7	8,863	16,073	+81.4
Increase service	30.6	18.9	20,090	12,818	-36.2
Lower fares	3.1	2.7	2,035	1,831	-10.0
Better bus scheduling and routing	7.7	6.7	4,943	4,544	-0.9
Miscellaneous	6.1	5.4	4,117	3,663	-11.0
Total	100.0	100.0	65,652	67,821	+3.3

Conspicuous by its absence was any great interest in fares. Only 3 percent, either before or after the service increase, mentioned lower fares. It is clear from this question, that increased service is the most important factor in the minds of persons riding the bus. However, it is also clear that behavior did not correspond with the attitudes.

TABLE 10

TYPE OF INCREASED BUS USAGE

Type of Increased Bus Usage	Percent [a]
Switched from other bus lines	38.0
More trips than before change	55.6
Never used bus before change	6.4
Total	100.0

[a] N = 504.

Conclusion

It has been concluded that there were very few differences in person or trip characteristics after the patronage increased. The "new riders" were like the old riders or, what is more likely, they may be the same passengers making more trips. There are some data to substantiate this.

About 13 percent of the passengers said they were taking the bus more often as a result of the increased service. These people were asked for clarification of their increased use of the bus. Only 6 percent were new riders; the majority were making more trips (Table 10). Furthermore, about 38 percent of this group added no new revenue to the public transportation system because they had simply switched to this bus line from another. In other words, according to the passengers, the increased number of buses had not actually encouraged many new riders. And how many more trips can a regular bus rider make on a bus?

GRAND RIVER RESIDENTS: 1953 AND 1962

Data concerning 1962 bus passengers cannot explain why bus usage has decreased so much over the last decade. Nor can they explain why so many "potential" bus trips are not actually made by bus.

To find out why this has happened, a sample of households within the Grand River corridor were interviewed (Fig. 1). Information was collected about the total trips made in these households on an average weekday as well as data concerning general modes of travel and attitudes toward public transportation. The interviews were administered during the third and fourth week of the increased service. (Time did not permit obtaining control data prior to the increased service. Thus any contrasts between intentions and behavior must be inferred. The data were contrasted to similar data obtained in 1953. Further information regarding any 1953 data used in this paper is given elsewhere (3).

At the time this paper was written, analysis of this part of the study was far from complete. This section, then, contains a few tentative conclusions and some examples of the data obtained primarily concerning changes over the past decade from 1953 to 1962.

During the past nine years the residents of the Grand River corridor have decreased the number of bus trips they take on an average weekday by 15 percent. This decrease becomes even greater when it is contrasted to the change in total trips; total trips in this corridor have increased 20 percent. Table 11 shows that this change in bus trips is very much related to area of residence. [For purposes of analysis, the Grand River corridor was divided into four areas on the basis of 1960 census data: median income, race, education and occupation. The entire corridor includes households of all socio-economic levels found in the City of Detroit (although not in the same proportions). The socio-economic level of the area rises going from Area 1 to Area 4 (1, Report II).]

Going from Area 1 to Area 4, the decrease in bus trips becomes larger whether those bus trips are examined alone or looked at in relation to total trips. In fact in Area 1 there is an increase in bus trips, although nowhere near as great as that for all trips. The decrease in bus trips along Grand River is much less than that for the entire city (53 percent) because this study area includes a greater proportion of "inner city" population (Area 1) where the bus is used more extensively. Conversely, it con-

TABLE 11

NUMBER OF TRIPS AND PERCENT CHANGE BY GRAND RIVER AREA OF RESIDENCE FOR TRAVEL MODE: 1953 AND 1962

Travel Mode	Grand River Area of Residence				
	Total	Area 1	Area 2	Area 3	Area 4
Bus trips:					
1953	70,735	21,054	21,815	15,014	12,852
1962	60,314	25,223	16,019	10,887	8,185
Percent change	-14.7	+19.8	-26.6	-27.5	-36.3
Driver trips:					
1953	220,201	22,179	45,443	72,737	79,842
1962	275,015	39,735	50,364	66,367	118,549
Percent change	+24.9	+79.2	+10.8	-8.8	+48.5
Passenger trips:					
1953	96,518	14,255	19,195	28,355	34,713
1962	123,517	22,890	22,594	34,899	43,134
Percent change	+28.0	+60.6	+17.7	+23.1	+24.3
Other trips:					
1953	5,725	3,829	630	825	441
1962	9,981	5,874	1,259	1,193	1,655
Percent change	+74.3	+53.4	+99.8	+44.6	+275.3
Total all modes:					
1953	393,177	61,316	87,082	116,931	127,848
1962	468,828	93,722	90,236	113,346	171,524
Percent change	+19.2	+52.9	+3.6	-3.1	+34.2

tains a much lower proportion of people living away from the CBD where bus trips have decreased the most.

Although this change in number of bus trips is crucial, particularly for running a bus system, it is not a complete picture. To begin with, though bus trips have declined, the use of all other modes has increased. (The one exception to this is Area 3 where total trips and driver trips have declined. This is due primarily to a population shift and secondarily to the employed residents not working a full work week.) Apparently, it is not just a simple matter of an individual substituting other modes for some of the trips which he previously made by bus. Rather, the data indicate that bus riders are making almost as many bus trips as ever, but there are fewer people riding the bus at this time than a decade ago.

There are other data to substantiate this. When all of the travel modes used by a person are examined together rather than each trip separately, specific changes over this past decade are evident. In Areas 3 and 4 for which there is complete information, people have not shifted from using the bus exclusively to using it only for some of their trips (Table 12). Rather, both of these types of people have declined while the person who does not use the bus at all has increased. But like previous data presented, the pattern is different for the two areas. In Area 4 they have become drivers and passengers, while in Area 3 they have now become passengers exclusively.

This difference between the two areas is primarily due to the difference in car ownership (Table 13). People in the area of highest socio-economic level (Area 4) have gone from one-car households to two- and three-car households. There has been no change in the average number of households that have cars (0.92). This can be contrasted to Area 3 where there is a slight decrease in the average number of households that have a car; accounting for their becoming passengers rather than drivers.

Many studies have shown that car ownership is a good indicator of trips. The first

TABLE 12

TRIPMAKER'S MODES OF TRAVEL ON AN AVERAGE WEEKDAY FOR AREAS 3 AND 4: 1953 AND 1962

Tripmakers Travel Mode [a]	Area 3		Area 4	
	1953	1962	1953	1962
Non-bus users:				
Drive and passenger	49.5	50.1	53.9	58.2
Passenger only	25.3	32.4	27.0	31.2
Total	74.8	82.5	80.9	89.4
Bus users:				
Bus only	14.9	11.7	10.6	4.0
Bus and other modes	10.3	5.8	8.5	6.6
Total	25.2	17.5	19.1	10.6

[a] Unit of analysis is individual tripmakers, classified by their combined travel modes on one average weekday.

car in the household undoubtedly causes the greatest change. Area 1 has increased in the number of households that have a car; the residents of this area have also shown the greatest increase in trips. Areas 2 and 4 have no change in the number of households that have cars but have more two-car families. Their trips have increased although not as much as in Area 1. And in all cases these trips have been lost by the bus system.

But to say that people do not take the bus because they have cars is to some extent "begging the question." For the real question is why people feel it necessary to buy cars. A car becomes important because of the decentralization of metropolitan areas and once travel habits are established it is difficult to change them. Thus, even if the bus is convenient, people are less likely to use it because they are now accustomed to driving or obtaining rides. Even though the child could walk to school, he is less likely

TABLE 13

RELATIONSHIP BETWEEN CAR OWNERSHIP AND HOUSEHOLDS FOR AREA OF RESIDENCE: 1953 AND 1962

Car Ownership and Households	Average									
	Total Corridor		Area 1		Area 2		Area 3		Area 4	
	1953	1962	1953	1962	1953	1962	1953	1962	1953	1962
Cars per total households	0.81	0.93	0.41	0.46	0.86	0.90	1.06	1.04	1.21	1.42
Car-owning households per total households	0.66	0.71	0.38	0.43	0.72	0.72	0.86	0.83	0.92	0.92
Cars per car-owning households	1.22	1.31	1.10	1.07	1.19	1.24	1.23	1.25	1.31	1.53
Car-owning households per tripmaking households	0.76	0.82	0.48	0.54	0.80	0.79	0.93	0.93	0.99	1.00

TABLE 14

NUMBER OF TRIPS AND PERCENT CHANGE BY TRAVEL MODE FOR SELECTED TRIP PURPOSES, RESIDENTS OF GRAND RIVER AREAS 3 AND 4: 1953 AND 1962

Travel Mode	Work			Shopping			Social Recreation			Personal Business			School		
	1953	1962	Per-Cent Change	1953	1962	Per-Cent Change	1953	1962	Per-Cent Change	1953	1962	Per-Cent Change	1953	1962	Per-Cent Change
Drive	44,366	42,800	- 3.5	13,877	18,258	+31.6	12,132	14,427	+18.9	7,195	12,292	+70.8	1,004	4,382	+336.4
Passenger	6,102	6,950	+13.9	5,612	8,919	+58.9	16,227	14,960	- 7.8	2,438	3,612	+48.6	2,638	6,572	+149.1
Bus	7,781	5,277	-32.2	2,533	912	-64.0	1,219	465	-61.9	970	1,096	+13.0	2,371	1,551	- 34.6
Other	1,505	1,263	-16.1	0	92	0	338	276	-18.4	63	184	+192.0	0	167	0
Total	59,754	56,290	- 5.8	22,022	28,181	+28.0	29,916	30,128	+ 0.7	10,666	17,184	+61.1	6,013	12,672	+110.7

to do so when his mother has the car. Before long, these conveniences are felt to be necessities.

These kinds of changes are evident from the limited data available at this time. Table 14 gives the changes in some trip purposes for Areas 3 and 4. The greatest decline in the use of the bus has been for shopping, social recreation, and school. Use of the automobile for all of these purposes has, of course, increased.

Shopping is a good example of the fact that changing habits and decentralization are more important factors in this decline than the ownership of a second car. A decade ago, residents of these areas did 33 percent of their non-grocery shopping in the CBD. This dropped to 8 percent this year. On the other hand, the suburbs now attract almost one-fourth of these trips, whereas in 1953 less than 1 percent went outside the city.

A bus trip to outlying shopping centers is often inefficient and inconvenient so that bus riders seek other modes of travel. As a result, they form new habits, perhaps ceasing to think of the bus any longer in association with their shopping trips. This explains why there has been such a decline in the use of the bus for those shopping trips that are still made to the CBD (83 percent in 1953 and 53 percent in 1962).

The grocery shopping trip, on the other hand, has changed more in regard to time than to location. It has become a once-a-week trip with the major peak in the evening between 7:00 and 9:00 PM. These are the hours during which bus service and patronage is minimal.

School trips show a very different pattern; the second car in the household is primarily responsible for this change. Both the students who previously took the bus and the ones who walked are now either driving their own cars or are being driven to school. In fact, about 20 percent of all trips in which the driver is a "chauffeur" are school trips. (This is not surprising to school authorities who must contend with increased parking problems. A part of this change is probably due to age. In the final report, these data are standardized for age so that the increase due to other factors can be determined (1, Report II).

One factor should be noted about the data in Table 14. The decrease in total work trips is primarily a result of unemployment in Area 3 at the time of the survey. Total work trips (and all specific modes except bus) increased in Area 4. Differences between 1953 and 1962 in the modes used are primarily a reflection of the destination. For example, about the same percent of work trips go to the CBD as in 1953 (15 percent) but trips made by auto drivers have decreased, whereas bus riders have increased slightly. On the other hand, the bus is no longer used as often to go to work places relatively near the home.

In summary, the limited data presented here reveal that, although there are still a number of people who use the bus as they did a decade ago, there is a significant group who no longer do so. There are enough cars available so that these people can either drive or obtain rides. This will undoubtedly continue because the increased ownership of cars seems to result in the need for more cars. People need a car because the city is decentralized and the city continues to decentralize because more people have cars. New habits and land use patterns are being formed so that many people no longer even consider taking a bus.

TABLE 15

SUGGESTIONS FOR IMPROVING BUS SERVICE: GRAND RIVER CORRIDOR RESIDENTS, 1962

Suggestions	Open Question (%)	Structured Question (%)
Increase service	42.8	33.3
Lower fare	12.5	31.6
Better bus routes	4.8	6.2
Better bus scheduling	8.2	8.9
Other	12.3	13.4
None	19.4	6.6

The possibility of attracting trips which could be made by bus is a major concern of those interested in public transit. For this reason, the final report of this study will include an analysis of "potential" bus trips. These trips will be compared to actual bus trips. The changes in potential trips over the past decade may help to establish a trend concerning the changes to expect in the future. This, then, can be applied specifically to the Grand River bus trips discussed in the first part of this paper to predict which will remain on the line in the future. However, objective factors cannot wholly explain why potential trips are not made by bus; attitudes towards bus travel add to the explanation.

For example, most of the respondents had relatively definite images of the kinds of people who take the bus. Almost one-fourth of the respondents described bus riders as people of lower social status than themselves, or people who have no choice (e.g., no car); no one thought of riders as being of higher social status than themselves. The majority either described riders as having a social status equal to theirs or used words that could not be classified in this manner such as "worker" or "women." People who did not ride the bus were more likely to have a negative image of bus passengers than those who did.

At the beginning of the interview, respondents were asked, "What suggestions would you make to the DSR (bus system) if you were trying to encourage other people like yourself to use a bus more often?" Toward the end of the interview the same question was repeated. However the second time, the question was "structured"; that is, respondents were given seven choices and asked to select the one they felt was most important (Table 15).

When these two questions are compared along with the one asked on the bus, it is evident that increased service is mentioned most often. (The same question was asked in the bus interview; however, there was an implied reference to the Grand River line rather than all bus lines, as shown in Table 9.) Very clearly this was paramount in the minds of the public. This can be contrasted with all other suggestions including "lower fares" which evoked little response until asked directly in the structured question. The importance of most responses, except "more buses," fluctuated with the situation and the manner in which they were asked. This leads one to question the importance of such responses in predicting exactly what would influence people to use buses more often.

CONCLUSIONS

Certainly the public believes that adding more buses is the most important improvement that can be made. Furthermore when this was actually done, the patronage increase was greatest on buses that increased their service the most. But the total increase for the three average days was only 3 percent. This certainly could not be considered a good return for the investment. On the other hand, the time and location of these increases were concentrated so that more patronage might be obtained with selected increases in services.

It would appear, however, that there is little chance of encouraging new riders; instead, any increase comes from persons already using the bus. The bus interview indicated that a large proportion of these people had no alternative travel mode, but the behavior over the past nine years indicates that as soon as a car is available they will also stop riding the bus.

This is well illustrated in this study. A desire for more buses was truly an established attitude in the minds of the public—and more buses were used on the Grand River line. The response to this was not encouraging. Evidently desire for increased service does not coincide with behavior. The question, then, of how to attract persons to public transit at any level of service, or probably at any fare, still remains.

ACKNOWLEDGMENTS

This study was sponsored by the Office of Transportation, Housing and Home Finance Agency, and the City of Detroit, Department of Street Railways, in cooperation with the Department of Streets and Traffic and the Institute for Regional and Urban Studies of Wayne State University. This paper describes that part of the study conducted by Wayne State University.

REFERENCES

1. Smock, S., "Public Response to Increased Bus Service." Wayne State University (1963).
2. Malo, A., "Grand River Transit Study." Department of Streets and Traffic, Detroit.
3. "Report on the Detroit Metropolitan Area Traffic Study." Vol. I.

Appendix

STUDY SAMPLES

Grand River Bus Sample

The sample was drawn to obtain representation of one average weekday, one average Saturday, and one average Sunday both before and during the experiment. To do this, interviewing was conducted over a three-week period before the increase in buses, and again during the second, third, and fourth week of the experiment. A sample of buses, and within this a sample of passengers, was selected and interviewed (Table 16).

TABLE 16

SAMPLE AND UNIVERSE NUMBER OF BUSES AND PASSENGERS FOR DAY OF TRAVEL: BEFORE AND AFTER INCREASED SERVICE

Day of Travel	Time of Service Increase	Buses		Passenger	
		Sample	Universe	Sample	Universe
Avg. weekday	Before	383	480	2,876	36,145
	After	395	755	3,280	36,707
Saturday	Before	105	299	750	21,276
	After	229	469	2,015	22,549
Sunday	Before	47	140	346	7,866
	After	91	229	663	8,550
Total[a]	Before	535	919	3,972	65,287
	After	715	1,453	5,958	67,806

[a]Three days.

Household Sample

An area probability sample was drawn of 928 households in the Grand River corridor. This included those existing households from the 1953 origin-destination study. The interviews were scheduled according to two factors: (a) each of the five weekdays were equally represented so that the total sample included travel logs for one average weekday; (b) respondents were alternated between the male and female household heads in order to reduce bias in the knowledge of trips made by other members of the household and to have better representation of attitudes.

Summary Remarks—Session II

E. H. HOLMES, Director of Planning, U. S. Bureau of Public Roads

•THE SECOND SESSION contains four papers. Although the author of the last one is not here, I have been asked to summarize it with the others.

I will touch briefly on the three papers already presented and then comment on Mr. Zettel's "Summary Review of Major Metropolitan Transportation in the United States." It is interesting to have heard seven papers describing some of the needs and problems of the metropolitan areas, then to find out from this review what is actually being done in the way of solving the urban transportation problem.

For Dr. Shryock to condense the 1960 Census into 20 minutes must have been quite difficult. However, there are a few highlights that are significant. The first is that in 1960, 63 percent of the population of the United States lived in urbanized areas. That figure shows the location of the problem.

The next significant fact is that the population of the central cities increased 10.8 percent, but their suburban populations increased 48.5 percent.

A more important statistic, based on the 1950 area, is that the central city increased only 1.5 percent and in one section of the United States there was actually a decline in the population in the area that was called central city in 1950. Thus, the area now outside the central cities represents two-thirds of the total population growth. This highlights the problem confronting us in the decades ahead if the trend continues.

This is one of the reasons why the work of the Bureau of the Census is important. From now on we will have regular reports from which trends can be established and which will be helpful to future planners in determining the real significance of this population growth.

It has been mentioned that one in five Americans changed his address every year. Consequently, the trip patterns of these one in five Americans have changed in some way. In any event, it is apparent that flexibility in transportation must be provided if these people are to be served as they will want to be served.

So Dr. Shryock's conclusions—not only his own, but also his references to others in the last part of his paper—are the indication that the SMSA's will continue to grow rapidly. He sees much more circumferential travel as one of the problems we must face in the future. He, again, anticipates longer work trips and decentralization.

We all had a general idea these things were going on, but it is certainly helpful to all of us. The Bureau of the Census and others doing this work should be commended for making this type of information available to the people who have the responsibility of planning.

The paper by Wynn and Levinson really takes over from Dr. Shryock's paper, even though it preceded it on this program. Their chart shows that the larger cities not only have larger population, but also greater density of population. They conclude that density is a variable to consider in looking at the over-all transportation problem. Another graph shows that car ownership is less as transit increases.

What is needed is quantification of some of the things we already know. The information presented here is going to be helpful to all planners.

It is also found that rapid transit is most successful when population density is high. Furthermore, it was noted that the transportation requirements of the future probably can be classified in three ways: travel between areas of low density, travel between high and low density areas, and service between high density areas. Obviously, in the first case we must look to the automobile and in the others to public transportation.

The problem of public transportation will be within the areas of high density and the areas of low density. That is where flexibility is bound to be required.

These two papers complement one another. It is difficult to summarize them but both have contributed knowledge that can be found only by study of these papers.

Mrs. Smock has presented an intriguing paper. In the first place, it reports a demonstration project financed by HHFA. I do not know whether this is discouraging or not. It sounded as though it must have been a little discouraging to the transit company. It did have 8.7 percent increase on Sunday and only 1.6 percent during the weekdays when perhaps it is more important.

She cited some conditions that made us understand why it was not more: a short period of trial and perhaps people would have shifted more readily had they known the change in service was available more than a few weeks. She did mention the transit company did continue on Sunday but the riders began to drop off. There may have been some effect of novelty in there. Again, those facts are important, particularly to HHFA and the transit industry generally, and all concerned with transportation.

To those concerned with research, the other—the comparison of the two and the investigation of the why of some of the facts that she found--is far more important than the actual change in ridership: to find out not only what people did, but why. Among the figures presented, only 6 percent of the increase represented new riders but over one-third of the new riders were people who merely shifted from one busline to another.

The principal criticism people had of bus service beforehand was the frequency. They did not respond to greater frequency by taking advantage of it.

Personnel in the Bureau of Public Roads are now engaged in reviewing and testing in a couple of areas a modal shift in connection with the national transportation studies just reported for Washington. One of the factors in that equation is, of course, time. Statistically, the shift appears sensitive to changes in time. If increase in frequency means buses running at shorter intervals, then the waiting time must be less and the time of travel must also decrease. I wonder whether the factor of time, the sensitivity, would be observed if it were tested in the case described in Detroit.

Also, we should look extremely carefully at the new experiment just under way in Washington in which there is to be considerable increase in service and reduction in fares. Mrs. Smock found, at least from the responses to the queries, that fare was not an important item, and went on to cite reasons why people are becoming more automobile oriented—their increasing ability to own cars and increasing affluence and the lack of another available form of transportation.

I got the impression from Mrs. Smock that with this increasing affluence and the spread of the urban area, with the flexibility of transportation now needed, with the mobility of employment, capital, etc., which is now possible, no amount of manipulation of fares or service is likely to change the increased orientation to the automobile. This is a conclusion I draw from her report. At least it will take a great amount of manipulation to cause any real change.

This work I hope is only the beginning in examining why people live as they do and why they do these things. The "why" is the key and not the "what" of transportation. We will look forward to the final report. It will be a significant contribution to knowledge.

Mr. Zettel's paper describes a very important job that has been done. The job was done as a result of a concurrent resolution in the Legislature of California to develop a prospectus for a Bay Area transportation study. In preparation for that, Zettel, Carll, and others whom he lists reviewed in great detail the work now being done in what he calls the major metropolitan area study. His report gives an idea of how nearly we are now approaching the study that the speakers who have preceded have said that we need.

They reviewed studies in 12 of the 16 metropolitan areas—those are the areas that Zettel describes--the major areas where studies are being made. They have examined and compared the various aspects ranging through organization, the financing and design of study, and finally the study methods.

The report examines the philosophy, the approach being used in the conduct of the different studies and how their analysis is carried on. They find differences, of course. One basic one is whether and to what extent transportation merely depends on land use or whether it can influence it to any substantial degree.

This study finds there are differences in exact views as to ways that transportation can influence land use. The people making these studies are uncertain. Thus, in the design of studies they are having to make accommodations for that so study can be carried on regardless of what the findings are.

They find that the differences result in quite a different approach in analysis. He lists different methods of analysis of land use. Without attempting to define these terms here, his point seems to be that depending on the assumption of philosophy a different modal is used.

Another difference they find is assignment trips. Here they find a variety of mathematical modals used in each of the studies and draw comparisons as to the conclusions from the application of those modals. Through all the studies there are threads of similarity, much greater similarity than difference, enough to cause the authors to define what they call a major transportation study. The following are some excerpts from his report:

For purposes of this report, a major transport study was considered to be one having at least these characteristics:

1. It involves more than one, and preferably all, means of local transport.
2. It deals in some degree with the principal phases of a comprehensive planning process, which include (a) an analysis of population expansion, economic growth, and land use in the study area; (b) a systematic description and prediction of traffic flows; and (c) the development and evaluation of a plan for a comprehensive transport system.
3. It uses basic "building blocks", such as several hundred or more geographic zones within the region, that are finely drawn and make necessary extensive data collection and processing by electronic methods.
4. It is financed by a study budget sufficient to support the collection, analysis, and evaluation of large quantities of data.
5. It has a broad base of "community interest", with city and county governments and various federal, state, and local agencies represented on the supervisory committees.

* * * * *

The Objective of the Study

Objectives of metropolitan transportation studies as found in review of recent undertakings are described in detail . . . [elsewhere in the] report. But a fair generalization might be that the basic objective is to provide comprehensive and continuing guidance to the development of transportation facilities which will meet the standards and goals of the community for which they are provided. Many of the earlier studies, and even a few of the present, claim no more than provision of information as their basic objective.

The more ambitious metropolitan transportation studies of the present set forth the development of an area-wide, comprehensive transportation plan as the primary objective. But from the outset a continuing study and planning process is envisioned. It is recognized that a plan is never "final"; hence provision is made for its continuing surveillance, refinement, and amendment.

* * * * *

Given the basic approach but always recognizing that flexibility is desirable, the procedural steps of the transportation study may be outlined as follows:

1. Prepare inventories for the study area of population, land use, employment, economic activity, transportation facilities and traffic patterns on a systematic basis; provide means for keeping the inventories up to date.
2. Study trends and determine relationships from which may be developed reasonable and consistent forecasts of economic activity,

population, population distribution, land use requirements, spatial arrangements, and transportation demands.

3. Prepare and evaluate alternative projections of land use and associated transportation development for the study area, together with descriptions of economic, social, political, and environmental consequences of each.

4. Submit the possible alternatives to policy leaders and the general public for discussion to achieve broad agreement upon a desirable and attainable generalized plan of land use and transportation development.

5. Refine and test the transportation plan, estimate costs for stages of development, subject plan to economic evaluation, propose division of responsibilities among agencies for implementation; recommend priorities and methods of financing.

6. Propose methods and structure for continuing collection and analysis of data, and for review, refinement and amendment of the plan.

* * * * *

The authors urge that the technique be used with caution, observing that the assignment process upon which it depends still yields only approximate results, and pointing out other imperfections in the economic analysis (among them, "the arbitrary designation of time value"). Some of the other studies express the intention of formulating similar methods for economic evaluation. This raises a question, however: in view of the advanced state of analysis in traffic survey techniques, why has not more been done in the vital field of evaluation? The problem of the commuter peak-hour demand dominates all other urban transport affairs, and the problem is recognized to be overwhelmingly economic in nature. Yet, little evidence is to be found, even in the Chicago report, that the peak-hour issue has received attention in keeping with its urgency.

Perhaps the primary answer is that evaluation is the final major step in the planning process, and the efforts of the study group have been absorbed in preceding phases. Another reason is that evaluation cannot be treated scientifically in the same way as prediction. Forecasting models can be stated in terms of trends and probability distributions. Normative models, to be cast into the scientific mold, require behavioral values which can be optimized, as maximums or minimums. To frame such models is a far more complex task. Besides, realistic evaluation of transport proposals must include a generous quantity of non-scientific, "institutional" considerations.

There is no fear nor do the authors imply that the study staffs that have brought this such high-degree of sophistication will not carry through with implementation of their findings. This summary of the Zettel report seems to point the way toward answering many of these questions.

In conclusion, though we plan for 10, 15, 25 years ahead, the projects being built today in the field of urban transportation are going to be with us far beyond the period being planned for. We plan for 20 years but are building for 50 or 100 years. The things we are building will outlive many other items in the city scene that concern us very greatly. Yet the adequacy of these facilities will be judged in the years ahead not by this generation but by the generation that follows. And if we can accept as credible the forecasts, they will be viewed by a generation of people with an affluence that is hard to comprehend at this time.

We have only to look backward 20 or 30 years to see whether at that time we could have accurately projected thinking into the future to see the great difficulties of 20 or 40 years ahead. The effectiveness of planning is going to be judged under those conditions.

Discussion

Frank W. Herring (The Port of New York Authority). —I would like to ask a question of Mrs. Smock. As I remember, there was a 13 percent rise during the rush hours. Would a program of that kind have seemed more profitable than presentation of the program of the sort that you described?

I have one more question. You made an extremely interesting comparison of 1953 and 1962. Are there any data available to permit evaluation of how CBD employment itself may have changed during that period?

Smock. —To answer your first question, these increases were concentrated. There was a 13 percent increase during the rush hours on the expresses, not on the local ones.

I do feel the service change could be concentrated and still obtain the increase in patronage, not necessarily only in peak hours, but the second increase was on Sunday —we have not examined that thoroughly enough to know when those increases occurred. But we do feel that some of this increase could be obtained with a more concentrated service.

As to the second question, we are going to examine more thoroughly the 1953-62 data to find out exactly what changes are due to population changes, include changes in the population as well as what changes accrue to travel behavior changes. Some of it is the same people changing habit. We are going to try to find out about both.

Robert B. Mitchell (University of Pennsylvania, Philadelphia). —Were the speeds of the buses and the relative speeds of the automobiles compared over the same routes?

Seymour E. Bergsman (Department of Streets and Traffic, Detroit). —The one point I did find out was that the increase in number of coaches on the streets would have an effect so far as the general traffic was concerned. This includes private cars as well as coaches. There was no change before or after.

Edmond L. Kanwit (Bureau of Public Roads). —It is clear from the data Dr. Shryock presented that in the original area there was almost no change in population, and therefore, in density of the central city. Most of the population studies have probably tremendous emphasis on the shift to the suburbs. My question is that I understand there have also been very important and dynamic changes, not of total population, but shifts within the center cities. I wonder if Dr. Levinson has any comments with respect to these?

Levinson. —In cities where the areas remain the same, a slight decrease is experienced in the densities. In cities like Milwaukee, where they annex a great amount of land, the density went from approximately 1,200 people per square mile in 1950 to approximately 1,800 people per square mile in 1960.

The concept of the centralization in cities is not new. Again referring to Chicago, a great many of the square miles of the city lost people from 1950 to 1960, with a gain in the peripheral or the outlying parts of the city. But going back to the census of 1900 you find some "lost" people between 1910 and 1900 and so on.

What this has done in terms of transportation is twofold. It has attracted large masses of people closer to job opportunities on the perimeter and therefore destroyed their central attraction to the downtown, for coming downtown--an average increase in length of trip.

In terms of rapid transit patronage, the heaviest patronage in Boston and Philadelphia and Chicago is not within the first three or four miles of downtown, but it is in the intermediate or outer rim of five or ten miles of the central area. In some cases they have almost had to abandon the coverage. It has been a redistribution of trips.

Robert T. Howe (University of Cincinnati). —Mr. Holmes in reporting on Mr. Zettel's paper said this was in preparation for a comprehensive transportation study of the San Francisco Bay area. The possibility would seem to exist that the Bay Area will be making an extensive transportation study at the same time a new rapid transit system is under construction. If so, is this really good planning?

Holmes. —To refer to Zettel again, it is not good planning, but I do not know that necessarily should be viewed in any spirit of criticism because perhaps the opportunity to do good planning has not existed. Now perhaps the conditions do exist for what would be called comprehensive planning.

I mentioned there were 12 of the 16 metropolitan areas of over a million population that qualify as major studies. Zettel said there are four areas where regional plans are not in preparation. In these places various transportation studies have been completed. San Francisco has the most elaborate but none of them qualify as major studies done in scope.

M. L. Manheim (Department of Civil Engineering, MIT; Joint Center for Urban Study for MIT and Harvard). —In both papers this morning and in Mr. Holmes' mention of Zettel's comments this afternoon, I detected a feeling that actually we cannot predict very precisely what is going to happen in any city. We probably need to evaluate alternative transport systems. We can probably make the prediction that we could identify what some of the most likely patterns of development may be but cannot identify precisely which one we will have. In particular as we move further into the future the variance in the prediction increases quite substantially. And yet Mr. Holmes mentioned also the facilities now being built will last for a period of time.

What we ought to be looking for are kinds of facilities that could be built which would pay for themselves in as short a useful life as is consistent with our ability to make accurate predictions into the future. Of course this is ideal and would not always be applicable in every case.

Holmes. —I think we can amortize an expressway in a very short time. For instance, they figured they could pay for the Schuylkill Expressway in six years. It is half-paid for but it will still be there. We are not going to take it away in six years.

How important is the question of amortization. In my comments I was referring to its actual presence as a feature of the city. It will still be there whether paid for or not.

I would say it is making a profit. Of course it will still be there. We are not going to tear up the Schuylkill Expressway. It is more permanent than things that we build in cities and amortize over a 40- to 50-year period.

Davis. —With respect to that, when I was discussing the matter of long-range planning with some of the people in a big electrical company in California it was recognized that enough power for these metropolitan areas requires starting 10, 15, or 25 years ahead of time. It means vast arrangements for estimates, at least where there is hydroelectric power, the problem of acquisition of water rights, the plans for developing very large dams, etc., down to the time when the power is to be delivered to consumers.

One can reasonably expect there will be a certain magnitude in population trends. They do not know exactly where this power is to be delivered but would not it be foolish to be unprepared? You should not gamble on your organization's not doing well. To supply this power as these areas grow, they begin to get into statistics as to where they should go—this active planning may begin six or eight or ten years ahead of time. They still do not know detailed locations of industry in a particular area or city.

Then perhaps for four or five years ahead they begin to see some of the major outlines of growth. Then as the particular subtracts begin to develop they can see where subdistribution stations are going to be. Anytime you make long-range planning you should not be frustrated by the fact there are going to be some gimmicks.

The point is that we are accumulating some of the tools by which we can do a somewhat better job in the years ahead to prevent random actions so that twenty years from now we will not be in a position where we cannot compete with the rest of the world.

Wagner. —Hopefully by sometime in 1964—maybe by the end of this year—we will be coming to conclusions with respect to alternatives and we will put the final ink on plans that will represent the conclusions of the Penn-Jersey transportation study. The actual concrete in the ground, the building of facilities, will be guided very definitely, possibly for the next five years, by reason of these decisions.

We expect a continuing organization to be in operation that will constantly keep up to date, be making new explorations, be coming to new conclusions so the decisions that may look good in 1963, as we get to 1970 or 1980 may need a new look. This is how it should be.

R. D. Bond (Ford Motor Company). —I would like to ask Mr. Levinson a question: Because of the population density factor and the trend toward decentralization of large central cities, is it possible to estimate transportation demands for the major central cities now and say it would not change too much in the next five years within the central cities regardless of modal split?

Levinson. —You can always estimate the demand. The question is to what degree of precision and with what tolerance. There are certain patterns of travel that are probably almost static in many streets. Some of the movement to and from the central area probably is pretty much the same today as several years ago.

Bond. —What I was thinking, say 1963, if you had been estimating the current transportation demands for a large city in a metropolitan area that has a million or more population and with a population density factor you have now and if you assume those density factors would not be increasing, would trip generation trends 15 years from now in such a large city be substantially more or maybe slightly more? In other words, 5 percent or 10 percent more?

Levinson. —To answer precisely I would like to have an O-D study of the city. We do know the trip per rider increase because of the greater car ownership. At the same time we know a consistent pattern decrease in transit riders. The greatest impact has been in the acquisition of the first car and the second car. I think that in many areas changes have not been profound in certain regional movements and these areas I think could pretty well be established.

Clifford D. Rassweiler (Johns-Manville). —To make a philosophical remark, I am always impressed that the discussion proceeds along the lines of assuming that there is something going to happen in population distribution twenty years from now, that we should try to predict what that is and provide transportation for it.

I wonder if there is not a little different approach? I wonder if there is not another point—the nature of that distribution twenty years from now which is going to depend on what we do in the next ten years. Some planning might be directed to what distribution of population around the great urban center would give the people the most satisfactory living and then start planning on transportation so as to lead the population in the kind of distribution which is best for it.

Wagner. —I am very glad you said that; that was what my opening statement said in general. I was once a little fearful that I might have fallen into the hands of these planned economists who try to rule our lives for us and all that sort of thing.

Now, I do not feel we should allow things just to drift. I think we need leadership to attain the kind of urban community we really want. It is not one man's job, the planner's job, it is the job of the elected officials, the civic organizations that represent the citizenry, as well as business leadership--a combined partnership that will help achieve the kind of area that will function, make all of our living more pleasant and enriched.

This is a real challenge to us in the future. The report of Philadelphia's commission with respect to the future of its downtown is an effort along that direction. I have great confidence we are going to attain it; only through this kind of effort can be really keep those values from being badly affected by transportation. If we let things drift, transportation will come of one kind or another. But it may hurt a lot if we do not study and plan and combine work at the leadership level.