Changing Land Use Patterns and the Forms of Metropolitan Areas of the Future

(SUMMARY REPORT OF PANEL 1 ON CHANGING LAND USE PATTERNS)

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Effective urban transportation planning is inseparably bound up with an adequate understanding of the evolving urban environment that is to be served by the planned transportation system. Adequate research into the causes and prospects of general urban change is essential to transportation planning for at least two fundamental purposes: (a) to project transportation demand and (b) to evaluate transportation proposals.

As to the first, transportation flows within an urban region at various future dates can be anticipated best by a simulation process based on projections of the spatial distributions of future residential and non-residential establishments and of the linkages among them. Urban transportation flows, except in the very immediate future, cannot be directly projected from data exclusively within the subject matter of transportation.

As to the second purpose, the potential side-effects of a specific transportation program on the nature of future urban change may turn out to be so consequential as to have an intrinsic importance transcending the direct transportation service intended. For one thing, transportation channels and terminal facilities may occupy substantial amounts of urban space and hence may drastically affect the continuity of urban districts. For another, the combined capital and operating costs of the transportation system preempt a sizable portion of the public and private budget and hence should be looked at within the framework of the larger budget that has to cover all needed elements of urban growth. And finally, the layout and details of the transportation system built tend strongly to affect the changing patterns both of urban development and of interaction among the many establishments that constitute the urban region. Thus, transportation indirectly affects both the productivity and the livability of the urban region.

It follows that a proposed transportation system should be judged quite as much for these ancillary effects as for its efficiency in moving people and goods. But, because other factors besides transportation are at work influencing urban change, the specific effects of a transportation program cannot be gauged unless adequate research has been done to identify the impacts of other factors and programs as well.

UNDERSTANDING URBAN DEVELOPMENT

An understanding of each of six major aspects of the urban region is essential to an understanding of the whole. Each of these might be viewed as a subsystem of the urban environment.

1. Natural Environment – The inherent geographic characteristics of the land as these affect what the land can be used for and the costs of development.
2. Structures – The characteristics of buildings and other improvements to particular sites.
3. Land Uses – The specific activities carried on by various numbers of persons in establishments of all kinds – residential, productive, recreational, etc.
4. Circulation and Communications – The networks of transportation facilities for persons and goods and of utilities and communications lines.

5. Accessibility – The potential accessibility of all sites throughout the urban region to other sites that might provide supplies, personnel, services, or consumers via the transportation, utilities, and communications systems provided.

6. Urban Interaction – The actual interactions (including transportation movement) among the establishments within the region via the transportation, communications, and other linkages available.

It will be noted that the latter three of these subsystems involve transportation quite directly and the others indirectly through their ultimate effects on the three. Of greatest significance, however, is the fact that the six are subsystems of a larger system – the processes of urban life itself. The more the subsystems are studied, the more evident it becomes that a reliable understanding of any of them depends on a better understanding of their interrelations as a whole. Indeed, it may be asserted that the present grasp of the several parts has outstripped the grasp of the whole and that the lag in gaining an adequate understanding of the interrelationships now threatens to impede further progress anywhere along the line.

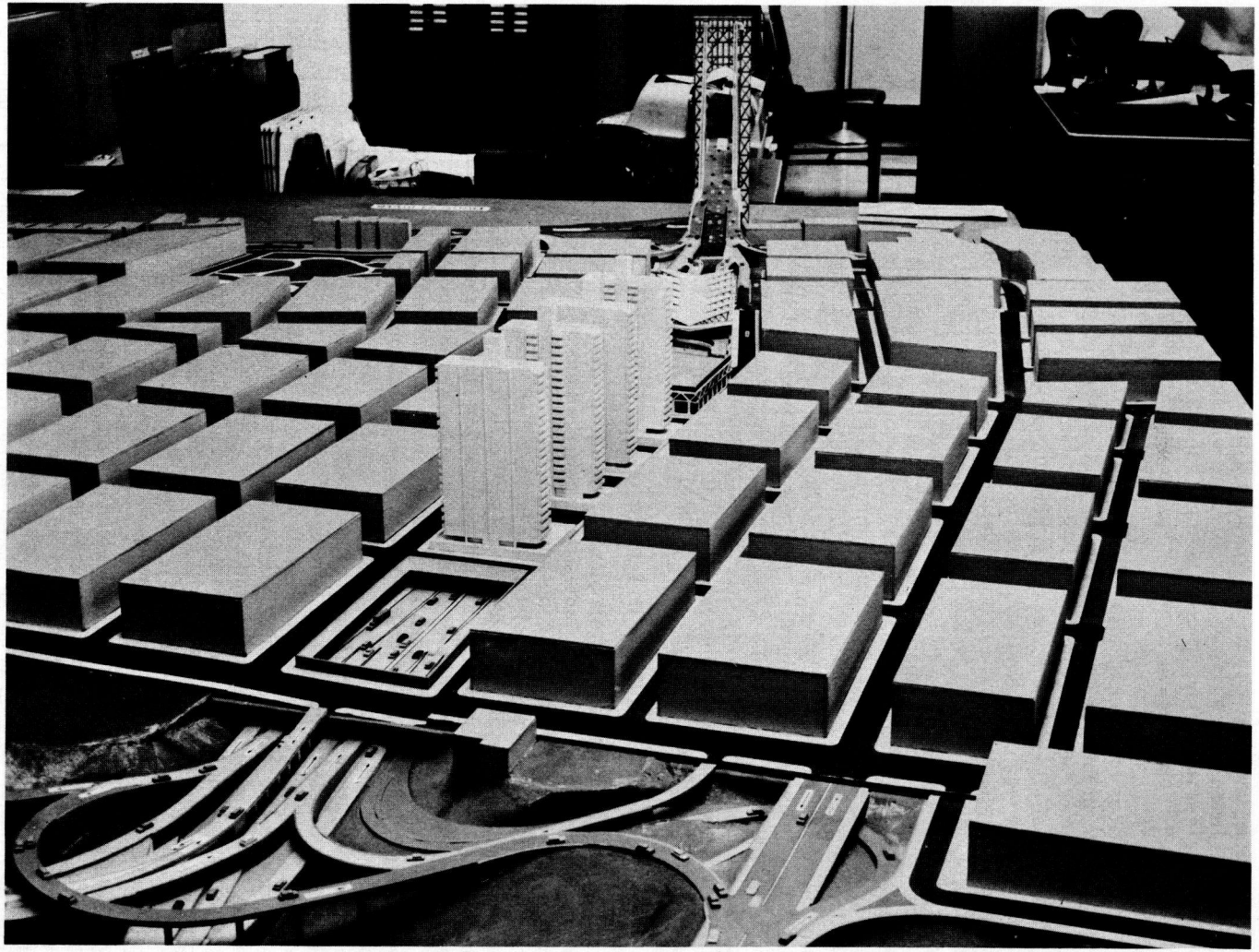
A very high priority, therefore, should be given to studies that probe the fundamental relationships underlying the dynamics of urban change. There should be particular stress on research into the interactions among the various subsystems that constitute the urban region. Work on parts of this problem currently is being pursued in a number of public metropolitan transportation studies and is being carried forward also at the Rand Corporation under a Ford Foundation grant. These present efforts will not prove sufficient, however, given the importance, urgency, and complexity of the problem. Greater research resources will be needed.

Panel 1 was given the topic, "Changing Land Use Patterns and the Forms of Metropolitan Areas of the Future." It is clear that these patterns and forms, although influenced by transportation, are shaped by many other forces as well – economic, geographic, social, and political. Despite the urgent and inescapable need to understand all these influences in order to make intelligent decisions about basic transportation matters, it appears that the scope of the research needed goes beyond the appropriate limits of the particular concern of the Special Committee on Urban Transportation Research. The subject, in fact, has a vital bearing on the work of scientists in a number of fields. Progress in the handling of many urban problems besides transportation depends equally on gaining a better understanding of the processes of urban change. Yet, it is evident that the broad research indicated is vital to the proper planning of urban transportation improvements, and this is a proper concern of the Committee. Panel 1 therefore recommends the immediate initiation of a review of the subject among all the Boards of the National Academy of Sciences for the purpose of assembling as much strength as possible for a new, vigorous, and sustained drive to support research into the workings of the urban region as a whole.

During the course of Panel 1's discussions, a number of specific research projects dealing with the comprehensive processes of urban life and change were identified and described. For the benefit of further exploration by a more appropriate group in the Academy at a later date, these are listed in Appendix B, Part II. The body of this report, however, will focus on research believed to be directly within the scope of the Special Committee on Urban Transportation.

UNDERSTANDING URBAN TRANSPORTATION AND ITS INTERRELATIONS WITH LAND USE

As long ago as the 1920's the concept of planning an urban transportation system as a complete network closely related to a land-use plan was set forth and illustrated in the Pioneering Plan for New York and Its Environs. The Regional Plan published in 1928 proposed a regionwide plan of land use to guide urban development over a long period of growth, perhaps 30 to 50 years. Especially significant, the plan also included a regionwide highway plan and a regionwide plan for the improvement of the railroad network. It recommended an extensive radial and circumferential system of high-speed rail passenger lines to weave the entire 22 county area into a single, albeit



Model showing use of airspace over approaches to George Washington Bridge, New York City.

complex, interacting urban community. The plan was developed with the aid of the most advanced civil engineering and regional planning techniques of its day.

What was not possible in the 1920's, however, was to test the proposed land-use scheme against the proposed transportation scheme, and vice versa, by projecting the transportation flows that would tend to occur if the region developed as recommended. By the same token, there was no way to judge whether or not the recommended transportation system was designed with the right capacities for its highways and rail lines.

In the most recent decade, however, planners, including transportation planners have been developing a number of new scientific concepts to trace, test, and project the interrelations of transportation and general urban activity. A series of signal advances have been made in the capability of making sound transportation plans. A number of new concepts have been successively made workable and added to a rapidly growing body of effective transportation planning procedures.

As might be expected, however, progress in dealing with the various factors involved has been somewhat uneven. Certain relationships were early reduced to workable mathematical models, others were less tractable and have remained insufficiently understood. The urgent need at present is to focus research efforts on the latter group.

Thus, although none of the component parts of the transportation planning process has been mastered in any ultimate sense, it does appear that research priorities should focus especially on the most important and urgent of the lagging parts. As was established above, the fundamental first need is to develop an operational capacity to understand and utilize the interrelations among the subsystems of the urban region as these act at a particular time and as they change over a period of time. Setting this subject aside, however, as too broad for the Special Committee on Urban Transportation Research, it is possible to identify the most significant other lagging elements in the evolving transportation planning process that are within the Committee's proper area of concern, as defined in the charge to Panel I.

RESEARCH TOPICS OF HIGH PRIORITY

It appears from a review of problems encountered in a number of recent large-scale urban transportation planning studies that special stress should be placed on research in about 20 subjects of special concern to Panel 1. These are listed in the text below. How the panel arrived at this conclusion is explained in Appendix A. The two parts of Appendix B list some 50 additional topics of the 70 from which the panel made its selection. Part I are topics that may be appropriate for further Special Committee action. Part II are topics that may be beyond the Committee's present scope.

For each of the 70 topics identified and considered by Panel I before top priority was given to 25, a standard rating sheet was prepared and carefully marked by a subcommittee of seven volunteer panel members. Fourteen elements of criteria were considered as the basis for grouping the research projects as to priority. These rating sheets indicate the subcommittee judgments as to such factors as research cost, time required, size of research staff needed, and most suitable research location. Since the judgments may be of interest, the summary sheets are reproduced for the 25 top-priority research projects in Appendix C.

Brief descriptions of the research topics included in the top priority group follow (no ranking within the group is intended by the order of the list).

Transportation Technology — Improvement and Acceptance

A tremendous amount of effective research done in the past has produced the vehicles, roadways, and control devices now used in transportation systems. In general, however, it can be said that many of the component parts, whether of the highway system or of the rail system, have been developed in some degree of isolation from many of the other parts. It appears that research on the technology of transportation is at a point in time comparable with the stage reached about two decades ago in the technology of weapons. In recent years the introduction of the systems concept in one after another field of technology has resulted in significant improvements not only in over-all control mechanisms but equally in the design of the individual elements that constitute the larger

system. A practical automatically guided and controlled vehicular system and a more efficient mass transportation vehicle and system are just two examples of what might be accomplished through research with a systems approach.

Research Topic No. 1 — Technological improvements in transportation through the application of a systems approach to design, construction, maintenance, operation, control, and financing. The approach should embrace all components of transportation systems such as highway and rail facilities, vehicles, interchange and terminal facilities, safety and control mechanism, etc.

Technological advances in many fields besides transportation as well as technological developments in the components of transportation itself will affect transportation in the coming years. Some of these prospective changes in technology already can be perceived. It is important to understand their likely impacts and to anticipate the results.

Research Topic No. 2 — The probable effects on future transportation systems of prospective technological changes in the component elements of transportation.

Many factors tend to impede the immediate application of new technological developments. Existing investment in costly plant and natural human resistance to change, for example, have a delaying effect. On the other hand, the competitive advantages of up-to-date processes, public pressures for improved safety, and other similar factors press toward the early adoption of improvements.

Research Topic No. 3 — Factors determining the rate of change in transportation technology and its acceptance. The probable rate at which public attitudes will accept or even spur changes in transportation technology. The influence of attitudes toward safety, cost, speed, comfort, convenience, and other similar factors.

Elasticity of Transportation Demand

The gradual build-up of traffic or of passenger patronage on an existing transportation link was the major factor used in forecasting transportation demand up to about twenty years ago. In this earlier period, traffic forecasting dealt almost exclusively with traffic count data; and it mainly considered the growth of demand on single links in the transportation network, one at a time. In recent years, however, it has become evident that traffic flow changes are the resultant of a complex of factors, many of which can be understood and anticipated only through the study of data about social and economic change as well as transportation change. Moreover, it is now seen that flows on single links are affected by changes on other links elsewhere in the urban transportation network. In brief, it is recognized that because of many interacting factors, transportation demand in many situations is highly elastic. But although this fact has become accepted, our capability for dealing intelligently with the elements of this elasticity is still distinctly limited. Hence the subject is an important area for fruitful research.

For example, the attraction of passengers to rail or bus mass transportation is considerably affected not only by the nature of the transit service offered, but also by how people get to or from the station stops.

Research Topic. No. 4 — The relative service areas, or zones of influence, of different modes of mass transportation; and the effects of various types of feeders provided, such as local bus feeder systems, automobile parking with and without parking fees, and free transfer privileges.

It has long been observed that transportation patronage tends to be affected by such factors as the levels of charges imposed and the frequency, comfort, convenience, and speed of service offered.

Research Topic No. 5 — Concepts and methods for determining the elasticity of transportation demand that occurs by virtue of improved or curtailed transportation services or that results from changes in the levels or methods of imposing user charges. This research should include the effects of speed, comfort, convenience, cost, privacy, etc.,

on the utilization of the transportation system and its component links. It should also develop means for determining the potential market for new types of transportation facilities and services not now offered.

Patterns of transportation flow are affected not only by over-all factors, but also by the details encountered by the traveler in the course of his journey.

Research Topic No. 6 — The influence on transportation patronage of such detailed factors as: (1) synchronization of service at places where the mode of travel is changed during a trip; (2) characteristics of the physical means of transfer; (3) costs, if any, of transfer privilege; (4) segregation of trucks and busses from passenger cars; (5) the nature of route designations on signs; and (6) provision of roadside facilities.

Transportation Flow Simulation

Before effective planning can be applied to the improvement of the transportation system, it is essential to know, with regard to the present measurable situation, who wants to go where at different times and by various modes of travel. It obviously would be impossible to determine this individually for every trip made; neither in the field nor in the course of surveys at establishments can every single trip be recorded. In response to the need for understanding existing travel patterns, however, methods for simulating transportation flow have been developed, especially during the past twenty years.

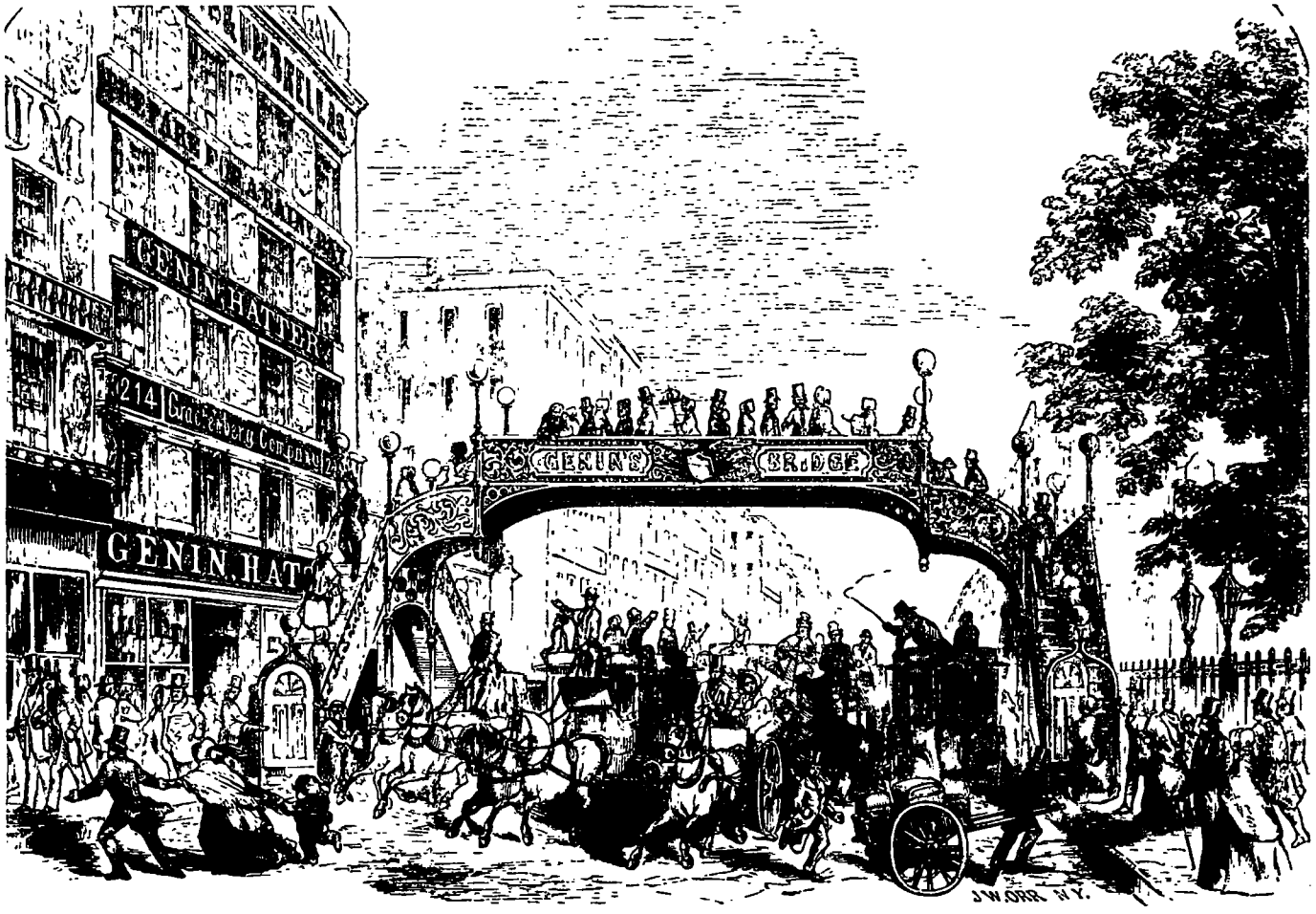
To date no one of the many methods developed is recognized as the most appropriate for any particular situation. As time goes on, it appears that even more and different methods will be developed, with the result that the field will tend to become even more confused. This experimentation is highly desirable. To be of maximum benefit, however, the new developments should build on one another rather than unnecessarily to duplicate previous experimental work. It seems wasteful to have separate organizations spend time developing substantially similar approaches to similar problems. In particular there is need to bring together and evaluate recent advances made in the methodology for simulating transportation flows using patterns of land use and specifications of transportation facilities and services as the basis for flow simulation.

Research Topic No. 7 — Fundamental component elements of mathematical models required to simulate the flows of persons and goods resulting from a given or projected transportation system and associated arrangement of land uses. These elements include considerations of accessibility; the generation of movement by different types of land use; the split of trips among different modes of travel; the linking of trip origins and destinations; the assignment of trips to particular links in the transportation network; the determination of the capacity of the various links in the system; the determination of the adequacy of facilities and services to carry the simulated flows; and other similar factors.

In recent years many urban transportation studies have attempted to simulate transportation flows by working with a sample of trips as reported in the course of interviews taken at the roadside, in homes, and in truck and taxi depots. There is some evidence that other types of samples might be satisfactory and less costly. Because huge sums of money are being spent annually on transportation surveys, it would be timely for a study to be made of the comparative advantages of the several possible approaches.

Research Topic No. 8 — The comparative advantages of transportation movement surveys directed to the standard survey locations (households, truck and taxi establishments, cordon stations, etc.) as compared with surveys taken at assembly points where people congregate and goods movement is generated (business, industrial, commercial, governmental, educational, and recreational areas).

The need to keep research manageable has pressed in the direction of distinguishing a relatively small number of types of persons making trips when trip-making propensities are analyzed and compared. There is some reason to believe that analyses of finer classification breakdowns might yield important and usable further distinctions among travelers.



GENIN'S NEW AND NOVEL BRIDGE, EXTENDING ACROSS BROADWAY, NEW YORK.

An early attempt to deal with transportation congestion. (Photo is from BPR file in Archives; it gives credit to Gleason's Pictorial Drawing Room Companion, Boston, 1852.)

Research Topic No. 9 — Similarities and differences in trip-making behavior on the part of particular subgroups and types of individuals within the larger categories customarily used in transportation analysis and projection.

Most current urban transportation studies deal extensively with the factors generating movement within, to, and from an area but lack the interregional geographic scope necessary for the projection of through traffic. While through traffic in the vicinity of a metropolis tends to represent a relatively small portion of all traffic, its absolute volumes can reach significant levels and it can be quite important, particularly to the through travelers.

Research Topic No. 10 — Concepts and methods for determining the present and prospective flows of persons and goods moving through an urban area that have neither origins nor destinations within the area.

Interrelations Between Transportation and Other Land Uses

To plan improvements in the transportation system, estimates of future demand are required. These commonly are based upon projections of land use, converted by means of transportation flow models into projections of movement by persons and goods. But future land uses themselves are affected to one extent or another by the evolving patterns of transportation services and facilities. Hence, a thorough understanding of the interactions is of the greatest importance.

Research Topic No. 11 — Comparative studies of the impact of transportation changes on urban land use changes, focusing on changes associated with identifiable transportation projects and making extensive use of descriptive and analytical before-and-after procedures.

Research Topic No. 12 — The "second-round" or delayed effects on levels and patterns of transportation demand caused by the accomplishment of transportation improvements — effects produced as a result of the acceleration of urban growth under the influence of improved accessibility.

The more the concept of accessibility is studied, the more evident it becomes that accessibility is a very complicated matter. A given parcel of land has not one but many measures of accessibility, depending on just who is proposing to make a trip to another destination, the purpose of the trip, the modes of travel and routes available, the time of the trip, and other similar factors.

Research Topic No. 13 — Concepts and methods for determining measures of relative accessibility, taking into account not only alternative transportation patterns available for making trips but also the particular opportunities for interaction inherent in specific alternative land use arrangements.

Research Topic No. 14 — The effects of various types of transportation service provided and the resultant relative levels of accessibility among the parts of an urban region on the development of various kinds of districts — for example, residential, recreational, central and suburban business, industrial, commerical, administrative, and amusement districts.

Transportation Flow Projection Based on the Projection of Transportation and Other Land Uses

For reasons already touched upon, the planning of staged improvements to the transportation system of an urban area depends in a crucial way on the validity of the projections made for the future patterns of land use. A number of recent urban transportation studies have been exploring the use of mathematical models run on high-speed computers as a promising approach to the complexities of land use projection. Comparative analyses of these efforts to date and the development of improved capacities for making such projections are urgently needed. Successful research along these lines undoubtedly would have many immediate applications.

Research Topic No. 15 — Comparative evaluation of the mathematical models already used or proposed for projecting the locations, characteristics, and activity levels of future transportation and other land uses.

Research Topic No. 16 — Concepts and methods for understanding and projecting the character, rate, and magnitude of change in urban areas, as a basis for anticipating future transportation demand, taking into full account the feedback between the transportation services provided and the land use patterns evolved. This research should encompass the projection of alternative land use patterns from which an urban region might choose.

As the parts of an urban region grow and change, their transportation requirements also change. Moreover, the limits within which they change are set in part by the characteristics of the transportation services provided.

Research Topic No. 17 — Concepts and methods for establishing what transportation services should be offered as appropriate to each kind of potential district, distinguishing different levels and different qualities of transportation demand.

As long ago as the early 1920's the idea was advanced that traffic congestion could be reduced not only by increasing the capacity of the transportation system but also by improving the land use patterns of an urban area. The aim of such improvement would be to reduce the average length of trips by achieving a closer geographic relationship of the land uses that need to interact with each other. Although this meritorious idea has gained considerable support, little progress has been made in the intervening forty years in making the idea operational. On the contrary, there is reason to believe that much of the urban change that has been occurring has resulted in increased rather than decreased average trip lengths.

Research Topic No. 18 — Concepts and methods for determining the possible reduction of total transportation costs through the gradual redistribution of land uses or the alteration of the linkages among establishments.

In some urban areas experience has shown that it is possible to project several equally possible alternative future patterns of land use, each with its respective transportation system. It is becoming increasingly important to develop satisfactory methods for making such projections in a manner that will facilitate intelligent choice.

Research Topic No. 19 — The effects of size and arrangement of the urban region and its subcenters on the effectiveness of their functioning and on their costs of operation. Points of diminishing returns and break-even point in elements or urban transportation services and other governmental services and utilities.

Research Topic No. 20 — Concepts and methods for expressing the costs and the consequences of alternative proposals, so as to facilitate intelligent choice among them. These considerations should embrace the physical, social, economic, and political aspects of the alternatives.

Transportation Data Management

Modern methods of planning and operating large urban transportation systems require the collection, processing, and maintenance of great masses of data. The management of these complex data has become a costly and complicated matter in recent years. One large metropolitan transportation study now under way, for example, estimates that its data currently consists of nearly one-half billion holes in punch cards. While experience gained in one transportation study or operation is transmitted to some extent to succeeding studies through informal channels, it is likely that an unnecessary degree of trial and error and duplication of effort is still the rule.

Research Topic No. 21 — Concepts and methods for collecting, maintaining, and processing the massive data continuously required for the planning and operating of urban transportation systems.

Appendix A

DEFINING THE PROBLEM AREAS

On September 14 and 15, 1961, a meeting of the Special Committee on Urban Transportation Research was held, the purpose of which was to develop a list of topics in the field of urban transportation which were in critical need of research. During the meetings of Panel 1 the discussions were not necessarily restricted to the field of urban transportation alone but covered the entire field of urban planning and design.

The discussions were started by reviewing lists of topics prepared by several of the Panel members which were prepared by reviewing the conclusions of the Woods Hole Conference, the Sagamore Conference, the Hartford and others. The few research areas thus suggested acted as a catalyst and precipitated a whole array of ideas and subjects which were duly recorded by the Panel Chairman.

From this lengthy list of ideas 66 research topics were chosen, stated in brief form and categorized into 13 separate research areas.

RATING THE RESEARCH TOPICS

Anticipating difficulties in determining priorities for these topics, a basis of rating them was developed. The resulting rating sheet (see Appendix B) covers a rather broad field of interest, including, it can be agreed, six basic areas; (1) need for project, (2) project size, (3) probability and feasibility of accomplishing the project, (4) most suitable research location, (5) timing in relationship to knowledge, and (6) directness of applicability to urban transportation.

Not all of these items are necessary in determining appropriate recommendations. Actually only items 1, 2, and 3, indicating need, and item 14 indicating applicability, were used with approximately equal weight given to each. However, the balance of the data collected will form a basis for later work by the Panel in implementing the actual research.

A group of seven volunteers rated each of the 66 proposals with which they were familiar, and on the basis of these replies the twenty recommended topics were chosen on the basis of the four rating items previously mentioned. It was interesting, and significant as well, to note the clustering of opinion received in the replies from this completely independent work from a relatively heterogeneous cross-section of people. Had this not been the case it would have been necessary to devise some alternate rating scheme.

Appendix B

I. Research topics that may be appropriate for further Committee action.

1. A "retriever" system, utilizing the most advanced techniques of electronic data storage and retrieval, to provide a central service to persons conducting transportation and associated urban development research anywhere in the nation, so as to provide immediate knowledge of research underway and of research findings completed on any pertinent topic of investigation.

2. New systems of goods handling – including improvements in: terminal design, containerization, freight aircraft, sea-trains, pipelines, vessels, rail facilities, trucks, etc.

3. Similarities and differences in transportation behavior on the part of particular groups and types of individuals within the larger categories customarily used in transportation analysis and projection.

4. The limits within which remote communication by writing, telephone, television, or other communication medium can be substituted for direct face to face conference.

5. The effects of prospective general technological changes on future transportation systems and on future urban patterns.

6. The interrelationships between various alternative transportation modes and various types of districts and corridors served by transportation, considering such

aspects as: capacities, costs, operational characteristics, and space requirements of the alternative modes. The relationships of these qualities to such districts as: high-intensity central districts; low-intensity districts adjacent to central districts; low-intensity industrial districts; and other areas of persons or goods assembly, including recreational, shopping, governmental, and residential districts.

7. Changes in location of persons and households displaced by urban renewal or transportation projects.

8. The effect of selected social changes on the patterns of transportation and other land uses – including the effect of: (1) changes in the distribution patterns of; income, racial groups, family types, etc. and (2) the effect of such innovations as; the patio and outdoor grill, etc. and (3) changed concepts of the work week, recreational demand, etc.

9. At the most basic level of understanding and definition, concepts and methods to describe the metropolis and its functioning in terms more fundamental than merely by reference to the: land use types, densities, and transportation networks that largely comprise the present analytical framework.

10. Identification of the significant elements and processes underlying and manifested in urban forms including considerations of the movement of goods to, within, from, and through urban areas.

11. Comparative analysis of existing urban areas, focusing on differences in the arrangement, quality, and quantity of transportation and other land uses.

12. Systematic comparative study of facts revealed by U. S. Census data with particular emphasis on: (1) the transportation parts of the 1960 Census, and (2) comparison of different places, at a particular time, and over time.

13. Land demand for specific purposes: (1) close to interchanges and (2) at break points in transportation.

14. Factors related to the patterns of open space that tend to occur under the influence of particular transportation system improvements – including: (1) the spatial distribution of open space, (2) the relative benefits of open space with varying degrees of accessibility, and (3) other similar factors.

15. Factors affecting: (1) the consumption of land, and (2) the locational decisions by: (a) families, (b) other households, (c) economic establishments, (d) public agencies, (e) places of assembly of persons and goods, and (f) farming within urban regions.

16. The changing nature of land uses and land use linkages in the ring just beyond the central district of highest pedestrian intensity.

II. Research topics that may be beyond this Committee's present scope.

1. The influence of transportation systems and land use patterns on transportation flows.

2. The effect of various neighborhood street patterns on the economics of mass transportation.

3. The relative influence of each of the various key forces that tend to affect the shape of urban development over a period of time.

4. National industrial and population changes and their prospective effects on urban areas.

5. The effects of changing population characteristics and behaviors on changes in land use patterns.

6. Factors that determine locational preferences and behaviors among persons who migrate to, within, or from urban areas.

7. The effect of the age of structures and neighborhoods on land use changes.

8. The processes by which one land use is succeeded by another over time.

9. The processes underlying the conversion of present buildings to new and different types of occupancy.

10. Factors affecting the development of raw land compared with factors affecting the re-use of developed land.

11. Elements of, and entering into, land use that are stable over long periods of time.

12. Restraints on changes in land use imposed by (1) institutional, (2) physical, (3) financial, or (4) other factors that may prevent the adaptation of land use patterns in response to new opportunities and demand created by transportation improvement.

13. Effects of ownership patterns such as: tenure, character of ownership, parcel size, etc. on land use change.

14. The nature and extent of the impact of public policy and prgrams in transportation and in associated region-shaping fields on the ways in which urban development changes over time.

15. The effects of federal, state, county, and municipal tax policies and revenue expenditure patterns on changes in urban form.

16. Theoretical urban forms that might become desirable in the future.

17. Methods for evaluating the over-all efficiency and productivity of a region in which transportation movement has been minimized by achieving a particular land use distribution including the development of an array of off-center business and industrial districts throughout an urban region.

18. Comparative costs of concentrated development as against; (1) scattered development and (2) other differences in land use patterns.

19. A regional accounting system to aid in the evaluation of alternative proposals for transportation and associated land development patterns, which can strike a grand accounting balance for all the social and economic costs and the consequences that can be anticipated.

20. Criteria for choosing among the alternative urban land use patterns that might tend to evolve in response to alternative transportation system development program.

21. The impact in both directions of governmental policies, programs, and public works on the one hand and urban transportation facilities and services on the other hand. Evidence of interferences with the potential benefits of public and private investments caused by programs that, though constructive in themselves, adversely affect other programs.

22. Concepts and methods for coordinating the full array of public works development (water, sewer, street, recreation, education, utilities, etc.) to arrive at over-all urban patterns that will optimize the net benefit of all public programs.

23. Concepts and methods for determining the demand over long time periods for the other public works that compete in budget planning with transportation improvements.

24. The manner and the extent to which government officials and the public might use better knowledge of costs and consequences when they decide among alternates.

25. The extent and nature of the processes by which the public exerts influence on the character of private development — including an evaluation of appropriate respective uses of incentive and controls.

26. The effects of such public activities as subdivision regulation, zoning, and other land use controls as well as specific types of public works programs including transportation programs, on urban development in specific places and over long periods of time.