

# What Is Needed for a Fact Finding Study of Intercity Transportation In the United States

## A Panel Discussion\*

### *Introduction*

On July 27, 1961, D. Grant Mickle, then Chairman of the Committee on Origin and Destination Surveys, suggested that a panel discussion on the intercity origins and destinations of traffic be included on the agenda for the 1962 meeting of the Committee. Such a panel discussion was organized by Harold W. Hansen. Subsequently, Harmer E. Davis, E. H. Holmes and J. Douglas Carroll, Jr., agreed to lead the discussion in each of three areas within the general subject.

At the suggestion of Dr. Carroll, background material was mailed to Committee members and nearly 100 guests who were in attendance at the January 1961 sessions of the Committee. This material was intended to stimulate thinking in advance of the proposed panel discussion so that basic considerations could be undertaken more rapidly.

### *Background*

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A factual study of the intercity movements of people and goods in the United States is one of the pressing research needs today. The problems which generate this need are neither small nor uncomplicated. The great number of transportation vehicles, the considerable extent of their use, and the extent of facilities needed for their operation are unprecedented in the history of man. Reasonably current information (Tables 1 and 2) shows something of the sheer size and range of transportation in the United States.

There are other problems, too. Sociological changes now taking place, accompanied by accelerating population growth and redistribution, have an important effect on the whole complex of interrelationships in the transportation field. Technological advances and other factors are sharpening competition between carriers; casualties of this warfare have an effect on the general economy. Understanding of the controlling factors is imperative to prevent needless waste, inefficiency and possible chaos.

### SOME PROBLEMS

Described as a "loose grouping of individual industries and individual efforts," transportation in the United States is afflicted with several ailments. Some of these are no doubt due in part to the piecemeal uncoordinated development of the several transportation modes over many years.

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\*Conducted under the auspices of the Committee on Origin and Destination at its meeting during the 41st Annual Meeting of the Highway Research Board (January 1962).

TABLE 1  
TRANSPORTATION IN THE UNITED STATES  
BY MODE OF TRAVEL

Mode of Travel	Vehicles in Use (no.)	Extent of Use (millions)
Highway:		
Passenger automobiles	59,892,000	571,090 veh-mi
Trucks and combinations	11,622,000	122,746
Commerical buses	76,000	2,876
School and non-revenue buses	188,000	1,459
Total	71,778,000	698,171 veh-mi
Rail:		
Freight cars	1,723,200	575,439 ton-mi
Passenger cars	30,000	17,533 pass.-mi
Locomotives	29,256	—
Total	1,782,456	
Air:		
Commerical	1,841	28,127 pass.-mi 3,167 ton-mi 10, hr
Business and private	70,627	
Total	72,468	
Water:		
Towing vessel and barges	28,227	109,131 ton-mi
Pipeline:		
Oil transmission	—	1,022 bbl/year
Gas trans. and distrib.	—	11,500,000 cu ft/year

TABLE 2  
EXTENT OF TRANSPORTATION NET-  
WORKS IN THE UNITED STATES

Network Type	Extent (mi)
Highway:	
Interstate	40,521
Primary	402,284
Local	2,960,481
Federal	107,374
Total	3,510,660
Rail:	
Line haul	384,500
Switching	7,600
Total	392,100
Air:	
Controlled airways	182,500
Airports	6,400 <sup>b</sup>
Water:	
Improved routes <sup>a</sup>	28,600
Pipeline:	
Oil transmission	182,982
Gas trans. and distr.	595,000
Total	784,982

<sup>a</sup>Excludes Great Lakes.  
<sup>b</sup>Number of airports.

Technological and sociological changes underlie some of these problems. For example, population shifts to cities, together with a higher standard of living, have brought about a massing of motor vehicles in the cities. Failure to plan and to provide street improvements that keep pace with this development is resulting in urban traffic congestion. Less evident, perhaps, but just as real, are the deficiencies known to exist on highways, roads and streets across the country.

All these deficiencies keep the standard of highway service inexcusably low and contribute needlessly to killing and injuring thousands each year. At the same time they add unnecessarily to transportation cost.

#### ILLINOIS AND MICHIGAN STUDIES

A pioneer research effort to come to grips with the factors controlling highway transportation was a pair of studies conducted during the period 1948-51, when the Michigan and Illinois state highway organizations reviewed their existing legal classifications of road and street systems. Although they worked independently, essentially the same techniques were employed.

Highway use was assumed to relate directly to economic forces operating in the state. These forces were known to fall generally into trade areas, which were identified. The focal points of traffic generation within trade areas were believed to be the market centers—cities, towns, etc. Indicators of economic strength were used, including population and bank resources of the immediate trade area, and newspaper circulation and assessed valuation of the trade center. It was found that the proportion of traffic passing from one trade center to another increased with the size of the centers and as the distance between them decreased.

Although these studies related to highway transportation alone, they were significant for at least two reasons: First, they represent an attempt to determine a scientific relationship describing the nature and cause of at least a portion of total travel. Second, although output from the mathematical processes were used to describe highway travel, the formulas tended to measure all movements regardless of mode.

## COMPETITION

Although these studies partially opened the door to greater knowledge, they represent but a very small fragment of the total transportation picture. There are other serious problems.

In the freight-hauling field, regulated truckers are facing increasing competition from private truckers, rail carriers and air carriers. The passenger and freight business of railroads has been declining. Although passenger and freight transport by commercial air carriers has increased steadily, future growth involves winning customers from other modes of transport who offer lower-cost service. As with private air travel, the relatively higher unit costs of commercial air travel have yet to be overcome. An inland water transport, despite some gain in volume, has not materially increased or decreased its share of the total cargo business. Competition from other modes—particularly pipelines—is a factor.

Competition and a variety of transportation modes are desirable, if not necessary. However, blind adherence to past practices without any attempt to fit resources to present and future transportation needs can result in needless waste and less-than-adequate service. The quality of transportation service must continue to improve. Costs must gradually be reduced.

## NEED FOR INFORMATION

Such a future is not inevitable. It demands realistic planning based on understanding and guiding controlling factors in this vast enterprise called transportation. This is the heart of the problem.

Adequate facts on the transportation situation are not available, and those which are on hand relate principally to regulated carriers. However, even these are generally not comparable between modes of transportation; therefore, they are not of use for the type of study to be undertaken.

With what is now known, one cannot accurately analyze intercity movements of people and goods on a nationwide basis when all modes are taken into consideration.

These intercity flows are believed to be the very backbone of the nation's transportation system. They are the major transportation corridors. Lack of factual data about these movements is a serious and fundamental research deficiency that is impeding improvements in the quality of transportation service and delaying reduction in cost.

## PREVIOUS RELATED WORK

An early effort to single out major travel corridors was that undertaken by the U. S. Bureau of Public Roads at the direction of the Congress. Published in 1944, much of the work for the report was done in the late 1930's. The report suggested a 39,000-mile network of interregional highways to connect most larger cities (of more than 10,000 population). These routes were to be as direct as possible and not deviate to serve cities of substantially less than 10,000 population. The system included appropriate links in and through the cities served, as well as circumferential and distribution routes.

## WASHINGTON STUDY

On the heels of the Michigan and Illinois road system classification studies referred to previously, came an exhaustive analysis by the Washington State Council for Highway Research. Using a similar approach, economic indices were developed to describe centers of population. Equations were then tested until it was possible to simulate, within reasonable limits, the low point in traffic volume between pairs of population centers. The study argued that this low point represented an approximate measure of the "through" traffic using the road. The study also recognized that a corrective factor might be needed when computing intercity travel desire between places 250 mi or more apart to allow for travel using other modes of transportation.

## NORTH CAROLINA SURVEY

During 1959 and 1960 the North Carolina State Highway Department further refined the Washington concept of through traffic by undertaking a special, area-wide origin-and-destination traffic survey in a five-city area. From the total of all trips, those trips having their origins and destinations in the five cities were selected. Having thus excluded trips with either a rural origin or destination, a gravity formula or model was developed to simulate observed intercity trips. Although the model was similar to the one developed in Washington, the basic concept differed somewhat. Instead of using economic data pertaining to a trade area, the North Carolina process used estimated population counts of the cities involved. Here, for the first time, was developed a formula which could be said to relate to highway transportation specifically.

Inherent in all the foregoing premises is an assumption that the major corridors were being defined, measured and sorted in accordance with their importance, function and relative use.

Subsequently, the North Carolina State Highway Commission applied its formula on a statewide basis. The quantitative measure of motor vehicle traffic interactance was used to classify all rural roads into functional systems.

## ASF STUDY IN IOWA

Concurrently but independently, the Automotive Safety Foundation was conducting a statewide study of road and street needs in Iowa. Using concepts similar to those adopted in North Carolina, the Iowa study applied a conceptual model developed by Alan Voorhees for simulating interzonal traffic flow in cities. The gravity model was used to produce an index of travel desire rather than the actual number of trips. It was assumed that the index was proportional to the actual number of trips having origins and destinations in the centers of population selected for analysis. The intercity travel study used 50 larger centers of population in Iowa and the surrounding region. Inherent in the Iowa study were the following concepts:

Population outside cities or city-like places is thinly distributed. When considered apart from city population there appear to be no factors which would cause rural trips to consolidate into major, statewide travel corridors. Accordingly, travel by rural persons was omitted from consideration.

Trips into and between smaller cities and towns, together with their relative location and economic strength, are not of such a nature as to cause these smaller centers of population to serve as control points for major, statewide travel corridors. They were therefore, disregarded as of controlling importance.

Trips out of larger population centers do not radiate equally in all directions but are attracted more strongly to other centers of population. The strength of the pull to other centers is directly proportional to the size of centers and inversely proportional to the distance between them.

Travel corridors lying between centers of population—particularly between larger centers—are the major travel corridors of the area or region studied.

Mathematical expressions for conceptual models do not of themselves indicate mode of travel unless fitted to data for a particular mode.

Only those trips having origins and destinations in cities are produced by the above process. Therefore, it is necessary to add city-to-rural, rural-to-city and rural-to-rural trips to each route to obtain a measure of total vehicular trips.

## CONCLUSION

The foregoing examples of what has been done relate to one mode of transportation; except for the Interregional Highway Study each was limited to a single state. A nationwide study of the scope here contemplated would be much more comprehensive. Because of the scale and extensiveness of such a study it is essential that controls be clearly set forth to guide the proposed study to a useful conclusion. This raises ques-

tions. What, actually, is needed to undertake a factual study of the intercity movement of people and goods in the United States?

What should be the scope of such a study?

Why should such a research endeavor be undertaken?

Is the know-how available to execute such a study?

## *Comments on a Proposed National Study*

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Interest in a national transportation study, or census, or survey, is not of recent origin. Any attempt to institute a large-scale nationwide study should take into account the lessons learned from past efforts. Public Law 671, 80th Congress (1948), and its subsequent history, and the NAS-NRC Study and Conference at Woods Hole in 1960, are examples of expressions of general interest and need. Proposals for a national transportation census have run into some opposition, however.

In connection with highway transportation, the studies by the Bureau of Public Roads leading to the report "Toll Roads and Free Roads," House Doc. 272, 76th Congress, 1st Sess., in 1939, and the report "Interregional Highways," House Doc. 379, 78th Congress, 2nd Sess., in 1944, represented substantial contributions toward defining a system of truck highways on a nationwide scale. However, active progress in planning for and constructing the National System of Interstate and Defense Highways during the past decade, together with mounting problems of urban congestion, have focused a large share of attention and effort, on the part of those concerned with highway transportation, upon developing information relating to intra-urban aspects of the highway systems. It appears timely and important again to give attention to the problems of intercity and interregional transportation, but this time on a new scale and with a broad perspective.

### WHAT IS A NATIONAL TRANSPORTATION STUDY?

The idea of a national transportation study means different things to different people or groups. To some it means merely a program of collecting more, or supposedly lacking, data or information about transportation on a nationwide basis. To others, at the opposite end of a spectrum, it means a report giving the views of the study group on what should constitute national or Federal transportation policy. It should be obvious that the mere collection of extensive statistics can be a sterile exercise, often resulting in wasted effort. And there are a number of examples of policy-study reports, prepared without adequate facts or understanding of the working of phenomena, that, after a short period of emitting heat but little light, gather dust in the archives.

I think what is really sought is better understanding of that technico-socio-economic activity (or phenomenon) that is called "transportation." What is needed is improved insight into the workings of this activity or process under changing technological, social and economic conditions. Insight is needed to aid in sharpening predictions of demand, usage and performance of existing and proposed transportation systems. What is desired is an improved base for rational and defensible planning and design of transport facilities and operations.

Obviously, a basic step in attaining better insight into any process or activity—natural, social or economic—is the acquisition of some minimum amount of factual information about the process. A concomitant step is the formulation of concepts or models of how the process works, which are successively refined to some degree of concordance with the real-life process. A parallel requirement is the capability of analyzing the process, using the data and models. The ultimate objective is (a) to be able to explain why things perform the way they do, and (b) to predict the performance and cost of the system under various possible conditions (inputs or demands, levels of internal capability, and ambient conditions).

Unless there is some preliminary understanding, however crude, of how the process or system works, it is difficult to know what data should be sought. Because of the enormous mass of data involved in describing the workings of a transportation process on a national scale, it is impractical and probably not feasible to blindly set in motion a vast data-collection system which would just accumulate statistics. Likewise, without the capability of analyzing, summarizing and synthesizing the information so as to ultimately produce or test workable concepts, the data and the models do not contribute to the ultimate objective of rational understanding.

It should be apparent that the three steps—data collection, model formulation and analysis—are intimately interrelated, and for the successful pursuit of a national transportation study all three must be worked together. This will take much thoughtful preparation and, ultimately, substantial resources for the support of a worthwhile effort. Such an effort is important and timely, and capabilities of accomplishing it are available or can be developed.

### AVAILABLE INFORMATION

If it is decided to begin working toward a national transportation study, it is not necessary to start from the beginning in designing such a study or preparing for its pursuit.

The highway field has a background of three decades of experience in planning interstate highway networks, and in recent years in several of the states (for example, California, Iowa, Michigan, Illinois) planning studies for trunkline state highways have contributed to an evolving methodology for analyzing and projecting intercity travel. Studies in the State of Washington, and recently in some of the large metropolitan areas, are contributing to the evolution of models of intercity traffic flows.

In the air transport field, studies in connection with a national airport plan, and for the national airway system, have contributed concepts and information on intercity movement of persons, in particular.

There have been other such study efforts. The point is that some backlog of information, some concepts of system behavior, and some analytical methodology, are available.

In addition, there are large masses of data, now more or less routinely collected, some of which certainly would be useful in contributing to the objectives of a national study as I have defined them. For example, with respect to freight transportation by rail, the continuous waybill sampling work of the Interstate Commerce Commission contributes some useful data on commodity movements. The main deficiency in the present over-all data-collecting activity is that it does not produce all of the kinds of, nor some of the key information necessary to really understand the workings of the national transportation systems; that is, there appear to be critical gaps in national transportation data.

Some of the appraisals of the status of the current data-collecting process are abstracted in the following paragraphs.

In the report of the Data Panel of the 1960 Woods Hole Study (NAS-NRC Publication 840) pp. 51-52, the following statement is made:

The following primary questions guided our evaluation of the adequacy of data pertaining to the transportation system of the United States:

Are available data sufficient to describe the performance of the various transportation activities?

Are they sufficient to enable one to understand the interrelationships of the various transport modes with each other, with the economy as a whole, including its international component, and with various regional and industrial sectors of the economy?

Are they adequate to allow understanding of the effects of transportation upon individual welfare, and the character of rural, urban, and metropolitan life?

Are they adequate to allow an informed assessment of the future developments in the transport field and of their effects on each of the above-mentioned areas?

Are they adequate to permit the formulation and validation of hypotheses which seek to explain the transport operations as a system phenomenon within a socio-economic framework?

Are they adequate to allow for timely and effective planning for defense needs?

In addition to these several questions addressed to the adequacy of type of data is this question:

Is the data collection system capable of providing information responsive to current and anticipated needs in a timely and efficient manner?

It was concluded that in important respects the data now available are inadequate to answer any of the above questions affirmatively. This conclusion does not minimize the usefulness of the data now available, nor the resources of the agencies which collect these data.

The panel report then examines the principal aspects of national data-collecting activities, and draws the following conclusions (pp. 59-60):

From a composite of the questions raised and our examination of the data problem, we concluded as follows:

Information is not adequate for scientific examination of the transportation system as a whole, nor its relationships to vital economic, social, political, and defense questions. Without such information it is difficult to identify important problems and promising methods for solution.

As research, experimentation, and understanding of the transportation system grow, there inevitably will be a need for data which are not now foreseen. It is likely that at least some of the required data will be outside the scope of interest and authority of present data-collection bodies.

The present aggregation of organizations collecting transport data does not now provide the information required for the satisfactory understanding of the transportation system as a whole and its ramifying effects. This deficiency should be remedied.

In the Doyle Report of 1961 (transportation study for U. S. Senate Committee on Interstate and Foreign Commerce), the following appraisal is made (p. 275):

#### B. TRAFFIC AND SERVICE TRENDS OF INTERCITY TRAVEL

To properly understand the trends of intercity travel, we should have facts that would relate travel volume to cities and would in addition show the origin and destination of the important passenger flows. Such data would give us a clear picture of the relative importance of regions and cities, the important city pairs in numbers of passengers exchanged, and an accurate picture of the geographic flow of traffic in varying seasons and such characteristics as average length of trip and vehicle used. Unfortunately, such information is not available for any mode of passenger transportation except the regulated air carriers. There are random survey materials on highway passengers, principally by private auto, in Bureau of Public Roads surveys but these are the responsibility of the States and are not carried out systematically nor repeated from time to time. There are no geographic passenger data for rail and bus since 1940 except for what may be implied from the operations of individual companies reporting to the ICC. Thus we are unable to make a

comprehensive geographic or traffic flow analysis of intercity passenger movement in order to identify the most important flows and the means by which the passengers move in these flows. The Government is indeed remiss for not having taken the necessary steps to secure adequate passenger movement surveys on a continuing basis through the years.

In the absence of market oriented travel data we must use total reported passenger miles by the various carrier groups to review the present trends. While rail and bus data are available for geographic regions, the boundaries differ for each mode, making the data incomparable.

Some of the conclusions drawn in the report by the Undersecretary of Commerce for Transportation to the Secretary of Commerce in 1956, on a "Program for a Census of Transportation" are (p. 1):

1. Comprehensive transportation statistics are required for many public purposes. They are essential to the conduct of the Nation's commerce, and the administrative and legislative processes of Government.
2. There are serious gaps in presently available transportation data.
3. Comprehensive transportation statistics can be obtained most efficiently through a program which utilizes existing data to the maximum feasible extent, and bridges the gaps by a series of interrelated basic surveys, with provisions for necessary supplemental research and developmental activity.

#### VIEWPOINTS OF SOME WHO HAVE STUDIED THE PROBLEM

There have been numerous considered judgments made concerning the importance of a nationwide study of some kind.

In the Department of Commerce report of March 1960, summarizing the study made under the direction of Williams and Bluestone, there appears the following statement (p. 9):

i. Census of transportation. This is essential to give shippers, carriers, and Government the same factual basis for policy and practice. It should cover sources of traffic in the manufacturing, agricultural, and extractive industries, as well as common, contract, private and exempt carriers in all modes of transportation. It should show both geographically and by commodity the weights, sizes, volumes, distances, rates, and types of carrier moving the traffic, as well as the reasons for carrier selection. It should be repeated at regular intervals to inform us of trends as they are developing, and to measure the effects of actions taken. Without such a regular census, rational price action by carriers is difficult, as is regulation upon the standards here proposed. Although obtaining facts about their transportation market is primarily a responsibility of the transportation industry, the Government should take action to correct this lack of adequate information.

j. Cost finding. A critical element in rate freedom is the concept of prices based on costs. At present, too little is known about the relative costs of transporting traffic via the several modes and routes typically available to shippers. A comprehensive study should be made to explore the cost-finding methods most likely to afford proper comparisons between the several forms of transport.

The effect of such a study cannot be overemphasized. Improved methods of cost analysis, when applied within a framework of agreed economic standards, will enable the transport



industries to set prices and establish services more rationally. Regulatory agencies can then set maximum and minimum criteria rather than specified detailed rates, and the carriers will have the normal managerial initiative of other American enterprises. And the regulated carriers can be equipped to meet the competition of private and exempt transportation where their cost and service capacities permit.

It should be noted that in this report a need for an improved approach to costing is emphasized.

In the report "Program for a Census of Transportation" to the Secretary of Commerce in 1956, appears the following statement (p. 11):

#### B. NEED FOR CENSUS BUREAU ACTIVITY

Transportation is the blood stream that nourishes and keeps alive and growing the very tissues of our economic welfare and our national security. The significance of adequate transportation statistics is strikingly indicated by the fact that transportation costs represent probably the third highest expense item in production, following only labor and materials. Accurate information about the flow of raw materials and finished products, as well as the transportation media available, enables private enterprise to solve many of its production and distribution problems. In Government, adequate transportation statistics are necessary for responsible agencies to carry out fully their regulatory and promotional functions, and for the planning and programming of national defense requirements.

#### SOME CONSIDERATIONS IN DEVELOPMENT OF A NATIONAL TRANSPORTATION STUDY

In the concept and planning of a national study of transportation such as is under discussion here, general scope might be somewhat as follows:

(a) The study would be concerned with developing deeper understanding of the nature and factors influencing the movements of persons and goods, which movements underlie the functioning of the national economy.

(b) This means, in turn, that the magnitudes and patterns of travel of persons and movements of goods should be determined and their characteristics studied for all modes of transport, and regardless of whether or not the persons and goods are moved by private or for-hire carriage.

(c) The study would be primarily concerned with the intercity and interregional flows. Among other things, it would enable a delineation of the main flows and corridors of movement, and an understanding of the patterns of intraregional and interregional circulation, as distinguished from local, or intra-urban, or localized rural circulation.

(d) The study should provide not only for obtaining information sufficient to develop a picture of national patterns of movement of persons and goods, per se, but should develop information concerning concomitant economic and social activity which creates the potential or the needs for movement. This would be an important and essential component of a study which is ultimately to provide a basis for predicting transport needs under conditions of changing economy and technology. Knowledge of such factors will be important in order to take into account the effects of shifts in industrial activity, employment patterns, and patterns of commodity utilization by our society together with other information.

Another basic question about which understanding is needed is the relation of the level of economic activity to transport requirements. There are indications that as an industrial society becomes larger and more complex, the volumes of communications and physical transport increase, not linearly, but with some power function. Another question to be considered is whether there is a trend toward regional economies which operate at some level of self-sufficiency, and how this will influence patterns and requirements of transport.

(e) The study should be so designed as to permit some estimation of transport requirements in the future resulting from changes in technology of transport and in communication. For example, what part of physical travel can or may or will be replaced by further use of communication (information and data transmission)? Or, with changing types of fuel utilization, or energy transmission, how will transport requirements and patterns be affected?

(f) An important factor that influences transport decisions are costs, or supposed costs. A comprehensive study should include determination and analysis of cost factors.

Various statements have been made concerning the possible scope of a comprehensive national transportation study.

The 1956 Department of Commerce report on a "Program for a Census of Transportation" proposed for 1958 (although it was never carried out) (p. 2):

The 1958 program should consist of the following interrelated surveys:

- a. Commodity Distribution by Land, Air, and Water Transportation.
- b. Passenger Travel by Land, Air, and Water Transportation.
- c. Truck Transportation Inventory and Utilization.
- d. Bus Transportation Inventory and Utilization.
- e. Air Cargo Commodity Movements.
- f. Experimental Surveys.

A supplemental report by Williams and Bluestone, in connection with the Department of Commerce study, "Rationale of Federal Transportation Policy," goes into a number of aspects of the cost finding problem (pp. 33-39).

The Data Panel of the 1960 NAS-NRC Woods Hole Study reported (p. 60):

Because of the interdependence between information and understanding, it is necessary that information functions be an intergral part of the assignment of a group whose basic purpose is to understand transport as a whole. Such a group should include physical and social scientists, and representatives of government, industry, universities, labor, and others with interest in transportation and its effects.

For the purpose of understanding the transportation system as a whole, the information functions should include:

- (a) the specification of necessary data;
- (b) the formulation of concepts and measurement techniques;
- (c) the establishment of procedures designed to ensure comparability of data where necessary;
- (d) improvement in the accessibility of data;
- (e) provision for coordination of collection and measurement efforts;
- (f) provision of advisory services to other groups engaged in similar activity.

It is important, in discharging these functions, that undue burdens be avoided. The group should not assume statistical and informational functions in the transport field now being performed by other agencies. Where feasible, this group should use existing data-collection resources.

We are aware that accomplishment of the data objectives listed herein would be expensive. Though we are not now in position to estimate such expense, we have little doubt that the improvement in the efficiency of operation of the transport system would vastly exceed the cost of such an effort. Moreover, it is felt that the creation of a data system as indicated would result in the elimination of much obsolete and unnecessary data.

## DESIGN AND CONDUCT OF A STUDY

It should be obvious that the design and conduct of a study thoughtfully aimed at the objectives herein set up, could be no offhand enterprise. A period of deliberate ingestion would be a requisite. And the marshalling of support would probably be difficult.

Although some of the features of data collection are obvious, such as origin-and-destination surveys of persons and goods, even the sampling design would require much preliminary thought as well as new techniques.

New ways of summarizing so great a mass of factual information would undoubtedly have to be devised, although expansion of the notion of desire lines could provide a means of illustrating the great major flows on main national corridors. But to develop sufficiently fine-grained summaries of diverse patterns of movement may require considerable ingenuity.

Research would undoubtedly be required in developing the socio-economic side of the picture, although some current types of regional economic analysis may give some sense of direction.

The final step, that of developing an adequate model, or models, of transport activity and its determinants to the point where they can be usable practically for reasonable forecasts, would undoubtedly be a process of iteration and successive adjustment or refinement.

## CONCLUSION

A national transportation study, of a type and scope implied in these comments, sounds complicated and difficult. It would be very complex and extremely arduous. But at least it is essential to think and plan in these terms.

### *Why a Fact Finding Study Should Be Undertaken*

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The need for these studies has already been touched upon. Furthermore, it would be most difficult to separate the need for data and the manner in which they are collected; the two are pretty much interrelated.

The previous speaker has mentioned the early study made by the Bureau of Public Roads at the time it prepared a report on toll roads and free roads, and then the later report on the Interstate Highways, which were then called Interregional Highways. It is true that some effort was made at that time to determine a system of highways based on the best economic data that could be found, including a review of all that had been produced by the Census Bureau and any other locatable source. The data studied pertained to such things as agricultural production, industrial production, population, and all of the factors that it was thought might influence highway transportation. These data were then spotted on maps, not with the techniques projected on the screen earlier (reference to the cartographatron), but laboriously and by hand. From this a system was laid out by eye that went through most of the dots.

This method was not as crude as may have been implied. After all, the routes of travel and transportation in the United States have been historically developed from the time somebody started walking from one place to another. There were many topographical, geographical and other features which determined the location of cities as they developed and at the same time developed the lines of communication between them. Sometimes route location was based on the possibility of communication between one city and another.

As transportation developed, the arteries of transportation developed and they in turn induced other population developments. In delineating a system of air travel, which is unfettered and completely free from any topographical or other limitation, a map of the airways of the country showed that these followed just about the same lines as have always been followed.

This interaction is found to persist; which means, to take one of the previous speaker's points, that there is no great advantage in collecting very large volumes of information unless there is some specific use for it, and unless there is fairly certain to be use of it. The method used twenty years ago in laying out what is now the Interstate System in perhaps the most rudimentary manner was dictated by the necessity of furnishing such a system. We were called upon to develop a system of 40,000 miles, and that is what was done.

The best economic data that could be found were applied in the way that was thought best. The highway system was laid out because the people of the country wanted such a system, and because the President urged it and the Congress voted it. It is now being built.

Many things have happened since then. No longer can the Congress and others be satisfied, especially in other transportation areas outside the highway field, by saying that this is good because this is the way the people want it. It has to be proved that what is being built for the people is needed and is economically sound.

This is found to be true in the cities every day. But certainly it is even truer when one is talking about a national transportation system of the type previously referred to. It must be recognized that the present position requires planning of a system not only for highway transportation, but also for a highway system in relation to other forms of transportation.

Much greater amounts of social, economic and other data are available now than were available 25 years ago. The Bureau of the Census has been collecting data and filing them away. These can be made available. Yet even that is not enough. We have been steadily advocating a census of transportation for many years. One has been authorized time and again, but funds have never been appropriated for that study even though it is broadly recognized that a census of transportation is needed.

So, first of all, there is the job of finding what is needed for wise planning of highways. Also, there will be no relief from all planning once the Interstate System is built. That is when planning will be needed more than ever. It took twenty years (from 1937 to 1956) to get the Interstate System approved and the first real money appropriated. It is not too early to think of what is to be done in 1972 after this present system has been built.

So there is the job of planning ahead in the field of highway transportation, knowing that the planning must be done in full recognition of all other transportation media in the country and the changing uses that will be made of them.

In highway transportation the primary concern is with people moving themselves and their goods around in their own vehicles. Most other governmental agencies that have responsibility for collection and use of transportation data are concerned with organizations that, for a price, are moving other people and other people's goods around in vehicles owned by these organizations. They have the job of regulation, which is an important one. However, the data they need are quite different from that needed in the highway planning field.

No one knows why some people move themselves or their goods as they do; neither does Walter Rainville when he is planning his transit system know just why some people ride on his train systems and some do not. But, that is what he needs to know, not only about people but also primarily about goods: That is where there is a very great lack of information and one which is most important to the future of highway planning.

One last thing should be said about planning a national system of major transportation corridors. One reason the Bureau of Public Roads set up an Office of Planning is that it recognized the importance of this function in the future, to the extent that it was deemed important enough to concentrate the activity of an entire office on that subject without interference from anything else.

A newly established Division of National Highway Planning has as its function exactly what is under discussion. We recognize it, and don't know how to do it; but we are going to call on everyone we can to help us. As highway officials and others interested in highway transportation, we must place ourselves in this broad picture. Also, the Highway Research Board must be placed in this broad picture, with all future work being fitted in with that of many other people. The facilities for which we are responsible

must be planned in an analytical manner, and not on an emotional or crude rule-of-thumb manner as has been done in the past.

## *Fundamentals and Techniques Essential To a Fact Finding Study*

J. Douglas Carroll, Jr., Director  
Chicago Area Transportation Study

If this study is needed, the problem is one of determining the actual dimensions. Can it be done? What is the state of the art today?

Let it be assumed that an effective study of national, interregional transportation can be measured in the ability of the study to simulate traffic interchanges sufficiently accurately so as to aid and assist in decision-making. This may be arguable, but is postulated as a condition of the study. Now, skipping over the really monumental problems of traffic by ground, by air, by pipeline, by rail and by automobile, and all of the communication exchanges and all of the traffic that pass through the telephone and telegraph lines, and all the potentials of these, concentration is focused simply on the quality of the predictive tools as they are today.

The crucial prediction is one of intercity traffic. However, a strong note of caution should be inserted here. Although there is a feeling that understanding and more accurate description of this factor are coming, there can be overoptimism with respect to this in the matter of national transportation.

There are at least four formulas to describe intercity travel or intracity travel. The first, traditionally called the gravity model, is

$$T_{ij} = k \frac{V_i V_j}{d_{ij}^n} \quad (1)$$

in which  $T_{ij}$  is the travel between points  $i$  and  $j$ ,  $k$  is a constant of proportionality,  $V_i$  represents the size of some place  $i$ ,  $V_j$  the size of  $j$ ,  $d_{ij}$  is some measure of the distance (cost, time, etc.) separating the places  $i$  and  $j$ , and  $n$  is an exponent that must be determined empirically.

The second is the description of the system developed in Seattle, which is

$$T_{ij} = k \frac{(V_i V_j)^{1/n}}{d_{ij}} \quad (2)$$

The third, developed by Morton Schneider, Chief of Systems Research for the Chicago Area Transportation Study, and known as a probability model, is

$$T_{ij} = V_i \left[ e^{-\ell V} - e^{-\ell(V + V_j)} \right] \quad (3)$$

in which  $e$  is the base of the natural logarithms,  $\ell$  is a determining parameter used to identify the probability density,  $V$  is the total number of trips lying closer to the zone of origin than does the zone of destination, and the other symbols are as previously defined.

The fourth, proposed by John Wardrop of the British Road Research Laboratory and similar to the one used in Toronto, is

$$T_{ij} = \frac{k V_i V_j e^{-\lambda d_{ij}}}{d_{ij}} \quad (4)$$

in which  $\lambda$  represents a constant of the system, a determining parameter.

Several other models were mentioned by previous speakers. The magnetic field theory is one of these, but the writer is not altogether familiar with all of them.

The four equations are given here to illustrate that many different kinds of functions are being used to describe the rate at which traffic interchange falls off with distance or time or cost. It should be noted that several things of consequence are involved.

In each of the equations the notations  $V_i$  and  $V_j$  appear. These represent the size of terminal places—cities, regions, nodes, zones, whatever they might be. Therefore, one of the first ingredients is to know what this measurement truly is.

What is the weight of  $V_i$  and  $V_j$ ? Is it population? Is it economic activity? Is it the volume of car ownership? Each investigator has his own special way of describing the volume, or potential, or background pressure at any one point that measures the propensity to generate trips or traffic.

It is also necessary to know what  $T_{ij}$  is. In short, what is a trip? This factor also is subject to individual interpretation. If a motorist stops at a service station to get gas, is that the end of one trip? If a person takes a trip from Chicago to Washington by air, is the trip from airport to airport or from home to destination? Is it a series of trips? The point will not be dwelt on except to indicate that the item in which there is interest must have a firm and measurable definition.

Finally, what is the appropriate rate of fall-off or decay? The gravity models and the theoretical problems have been mentioned, but none of these formulas fits a perfect description or leads to things not previously known. These formulas are useful and effective in their description, but none has yet been demonstrated to be a superior model in describing the form of growth or decay. Therefore, we are not yet ready to step up to this next scale—a national transportation study—with confidence.

There is one other point to be made about scale, supplementing what has been said here. As previously mentioned, the Federal Aviation Administration collects all kinds of travel information. Lately, Gene Letendre of the Penn-Jersey Transportation Study, Philadelphia, Pa., has been converting the nation's air flights to map form. Using the special purpose electronic display device called the cartographatron (see pp. 86-108, HRB Bull. 253), he has been drawing pictures of one day's aircraft traffic for the Federal Aviation Agency.

For example, it is known that the jet pattern is the long-distance pattern, but the minute that many data are brought to bear, a much clearer picture emerges. So, too, it is seen that the piston flights are short flights and the turbo-prop flights are of intermediate length. From the "all flights" map the massive pattern of commercial air traffic over the country is seen.

Obviously, at the national scale the interest is in a different set of parameters and different set of problems. The formulas we have been finely "tuning" to describe traffic flows between zones in a city may prove to be quite inadequate for a nationwide study of the intercity movement of people and goods. This is to say that a great deal of work is still needed to reach the required scale.

But I end on a positive note because our "hardware"—our equipment, our muscle power—is substantially greater than it was 20 years ago. We have the capabilities of computers, of automatic devices, of a substantial range of data-collecting and data-amassing systems, and a great deal in the way of new techniques, new strategy, operations research, systems analysis, etc.

So the time is ripe. It would be wrong to promise that we know how to do this job, but it should be done. We should go forward to break into this new scale of traffic analysis.

### *General Discussion*

ALAN M. VOORHEES, Alan M. Voorhees and Associates, Washington, D. C. —I thought that when Dr. Carroll was describing all the various models now being used in urban transportation planning he was going to indicate that the main thing they had in common was that they only used two variables. Maybe this is the trouble. Messrs. Davis and Holmes both seemed to indicate that socio-economic factors are important. However, these are not presently included in the traffic models. Several papers sched-

uled for presentation at the 41st Annual Meeting of the Highway Research Board indicate the importance of these factors, and it appears that these factors are even more important when involved in intercity travel. Therefore, shouldn't efforts be concentrated on these socio-economic factors in developing national transportation models, as well as on the other factors that are now being used in the traffic models in urban areas?

DR. CARROLL. —That is a tough question to answer. We must first know what causes this massive exchange of people and goods. Then it can be splintered off into air traffic, pipelines, etc., if that is desirable. The additional ingredients which are part of the more refined picture can then be used to better define the massive picture. But the massive picture comes first.

MR. VOORHEES. —There has been a great deal of difficulty in simulating traffic between major cities with the various models that have been described. For example, the travel patterns between New York, Los Angeles, San Francisco and Miami are quite different in nature. Some of this difference is related to seasonal characteristics and some is related to socio-economic characteristics. Therefore, these factors cannot be ignored in intercity travel.

CHAIRMAN HANSEN. —Although that is a different approach, it is aimed at getting a better way of simulating observed events.

ANTHONY R. TOMAZINIS, Assistant Research Professor of City Planning, University of Pennsylvania, Philadelphia, Pa. —I would like to approach this problem from a different point of view. The problem for me is not the kind of data or the amount of data which will be required, but what will be the objective of such a study?

If the objective is simply to predict the magnitude of travel without consideration of human behavior, much trouble will ensue. That is, transportation needs must be projected as a function of human behavior and as a result of the interactions among economic activities. No transportation engineer should come up with a projection of transportation trips 20 to 25 years hence without considering human behavior and economic factors.

We should consider a much larger framework upon which to build before establishing the number and the mode of trips which will be generated in this country, or the length of these trips, or their destinations. There is a tremendous problem here of predicting human behavior and establishing transportation demand in relation to the income and price elasticity of the commodity and the tendencies toward a level of "optimum" transport inputs by type of household, type of activity, areal location, and income level.

Then there is the problem of projecting non-person trips (commodity movements). This implies projection of industrial or regional specialization. Transportation engineers cannot achieve a factual understanding of this subject, hence cannot propose acceptable solutions unless they include in their study group people with other skills or unless a different approach to the subject is established than a strictly engineering study can express. Besides, the problem and the degree and type of industrial specialization which might be favored or penalized by such a transportation study is obviously much broader and more complex than a mechanical projection of trips could denote.

A third problem is measuring the amount or the size of industrial activity in the United States. Even this job is much smaller than the tremendous job of projecting modern industry into the future. The means are not currently available to satisfactorily simulate modern industrial activity. A nationwide study of transportation should, however, be concerned with this problem and make every projection with the implication of this problem incorporated with regard to both the amount and the pattern of commodity movement, as well as the most appropriate or economical future mode of travel.

I am not much concerned with the amount of data and the problems of developing the particular mathematical relationships required to simulate present traffic patterns

and, later on, projected traffic patterns. Substantial improvements in existing mathematical models are possible. Inasmuch as rapid improvement of these models has occurred during the past few years, we should be optimistic on the subject. We may even find that there have already been important improvements in some cities. But I would express my utmost concern about the framework on which such a study should be built.

ROBERT T. HOWE, Associate Professor of Civil Engineering, University of Cincinnati, Cincinnati, Ohio. —A possible solution or way of gathering these data was suggested at the 1960 meeting when a representative of the Pennsylvania State Highway Department spoke on their statewide, screenline origin-and-destination survey. Does a possibility exist of throwing substantially simultaneous screenlines in a north-south and east-west direction across each state to intercept all transportation?

MR. HOLMES. —There is at present a Mississippi Valley origin-and-destination survey that has been carried out by a dozen states. I believe it was the brain-child of T. F. Morf of the Illinois Division of Highways.

That seems to be a thoroughly practical way to do it. Good information can be obtained as to what movements are actually taking place. It does seem, however, that in looking into the future, that is only a partial answer to the question. Attempts have been made at various times, without much success, to see if we could infer from that not only what is happening, but why.

We must know why people move their goods as they do, or move themselves as they do, if we are to be able to predict the future. That is why we have had the view recently that it is difficult to get complete information from the field. To know why people move themselves or their goods as they do, one must go to the people who actually buy the transportation. In respect to commodities, that would be the shippers. Person movements by motor vehicles are somewhat different. A person traveling in his own automobile is driving it himself and buying the service himself. One can therefore talk to the purchaser at any place and time.

But with "for hire" transportation one has to go to the shipper to find out why the goods are being moved. That is the thing that concerns us more than anything else.

EDWARD M. HALL, Street Improvement Administrator, City of Phoenix, Ariz. —We are spending vast sums of money in urban areas; money for studies which point to even vaster sums to be spent in cities and elsewhere. There is some discussion as to whether all modes of transportation require the expenditure of these vast sums of money.

The question is: Wouldn't the same effort directed at urban area transportation problems and relationships produce a more urgently needed answer to serve 70 to 80 percent of the people—the urban traveler? Stated another way, would it not be better to tackle first things first?

CHAIRMAN HANSEN. —It is true that urban population includes the majority of the people in the country. Depending on the definition of "rural" and "urban," it can be as high as 76 percent urban.

But the people living in cities do not live on islands apart from everybody else. In the United States they create about three-fourths of the travel on main rural roads. This is a part of the answer to Mr. Hall's question. That is, it is necessary to the whole posture regarding urban transportation that consideration be given to the relationship of each city to the whole.

This is not an endeavor to put the city dweller at a disadvantage and the rural man at an advantage. This is not what will happen. It is the intent to gather information on what is actually going on in the total transportation system comprising a group of subsystems, one for each mode, without discrediting the necessity to study individual components—that is, individual cities and metropolitan areas.



WILLIAM S. POLLARD, JR., Partner, Harland Bartholomew and Associates, Memphis, Tenn. —It has been established that this type of information is needed. I would like to suggest as a possible beginning the listing of the many variables affecting a projection of this type and the definition of their parameters to isolate the problem areas and their interactions. This obvious first step would re-emphasize the need for caution.

Surely it is recognized by all that any such effort would lead to a set of projections of the "if. . . . , then. . . ." type. Huge families of considerations would thus be described. Depending on trends or policy, it would be possible to choose from many concepts rather than any one optimal concept. This would avoid the danger of concluding that in the year "X" this Nation is going to be "like so," with reference to these things.

CHAIRMAN HANSEN. —There is no intent to "straightjacket" the uses for results from such a study. In a letter from James S. Burch, Planning Engineer of the North Carolina State Highway Commission, to be presented later, he points out that it would be dangerous to think that a study of this character should eventually lead to greater Federal controls over transportation.

Greater controls, or for that matter any change in control, is certainly not an objective of such a study. The real objective is to obtain new knowledge so that one can, for example, speculate with more certainty as to what alternative situations might produce, if tried. A study of this character provides an inexpensive way to look more closely, more realistically, and more factually into the future. This is the intent behind much of the discussion here.

PAUL W. SHULDINER, Assistant Professor of Civil Engineering, Technological Institute, Northwestern University, Evanston, Illinois. —A brief comment is suggested by these remarks in the matter of feedback of the results of the study, whether it be in terms of policy, pricing, or otherwise, or physical construction on the basis from which projections have been made. This is something we have not been able to do yet in the urban areas. However, it cannot be ignored as an important item in the study proposed here.

THOMAS FRATAR, Partner, Tippetts-Abbett-McCarthy-Stratton, New York, N. Y. —How will the information be used after it is obtained, and to what extent may some of it be simply in the form of wish fulfillments? Take jet transports, for example. A study is made and it is decided on the basis of the best hypothesis that there is a potential for increased travel from one place to another. The airline puts on more flights, and as a result there is more travel.

MR. DAVIS. —The fact that Mr. Fratar has raised this kind of comment is a confession of our national ignorance. If reasonable or rational decisions are to be made under conditions of change in the future, there must be some basis for making a judgment other than political pressures.

One of the fine things about our democratic system is that, having reduced certain kinds of phenomena to a scientific explanation, we can get together and arrive at some compromise in which we decide that this is the way we will do it until something better comes along. We are approaching a condition where such rapid changes are being made in technology, in location of our economies, and the shaping up of regional economies which transcend the single shapes, that these can be expected to have a very large impact on transportation requirements in the next generation.

Preparation should be made for it. The objective is not to tell somebody what to do, but to try to get "one up on" a better understanding of how this phenomenon works, together with the variables that influence it. In a group such as this, concerned with better transportation, there can be no better justification than that it really has a responsibility to society for offering the best kind of judgment, information, and analysis that is possible, because these people derive their living from working in transportation.

The potentials are at hand to improve that understanding. If we simply toss it off, we are negating our responsibility.

JOSEPH KATES, President, Traffic Research Corp., Toronto, Ont. —This is building up toward the proposal of a huge, very lengthy study, a lot of which probably is necessary.

Such a study probably will be used for two quite distinct things. The first is to help make policy decisions on the relative allocations of efforts to different transportation systems and different transportation modes, such as between highways, pipelines, railroads, airlines. That is really the number one transportation problem today in the United States and other countries as well.

To help the government do this, as massive a study as is seemingly emerging here is not necessary. It is not a requisite to picture every highway between every city, and everything in detail. What must be determined is the effect of putting different amounts of emphasis upon these different transportation needs.

That brings us to Mr. Fratar's question. In jet transportation enough data have been collected to tell what the influence would be on travel by jet as a function of just two things—cost and time. As fares are being lowered or raised, on the one hand, or as the supersonic jets are accelerated or slowed, one can determine what amount of travel can be expected.

Rough volume of demand is the first thing that can be determined from such a study. The second is the cost to provide service at different volumes and different speeds. What would be the cost to the aircraft industry? Or what would be the national cost for a reasonable standard of service?

When these two things are known the airline industry might know the optimum volume at which to operate. To go much farther may put the industry in trouble, as it has been in the past few years. If it doesn't go as far, then it might not make as much money and the service might not be as good.

The same thing also holds true for highways and railroads. The first objective of such a study should not be to get a detailed pattern geographically across the country, but just a simple economic study to help decision makers and law makers decide what should be the relative effort between different alternatives. Having determined this for each transportation system (the railways, the highways, the airlines, etc.), subsequent work would then have a target to shoot at.

Then there is the second problem—the design problem—which has been very much in mind during the discussion. How can we now design a U. S. highway network or an international airway network that will fit the demand, the laws, and so forth? How much do we intend to allocate to highways, to railroads, to airlines, etc.

Can the study be broken up into two distinct parts? One, not nearly as large as imagined here, would be a general economic study to help the government get a better insight into the effect of decision-making relative to allocation of effort to various means of transportation. The other, for various organizations interested in their specific transportation methods, would lead to developing data on which to base their design.

MR. CARROLL. —That is a very persuasive statement, Mr. Kates, but it is based on the premise that traffic can be described accurately, which is quite the contrary to what has just been said. If it could be described accurately, there would be the second problem, which is that of assisting someone in making decisions.

This is a question of values, and involves a fairly deep study of those regions in which decisions and values are specified by decision makers. At this stage we are short of this armament and this concentration, because the whole transportation system in the United States is affected by divers regulatory agencies, without clear-cut over-all government policy. There are a number of reasons of this kind. The bulk of all the congressional and other studies has been directed toward this policy arena without effect. Until such time as there is common understanding and a policy-making group which can apply factual estimates, there may be some difficulty in finding a market for the strategy proposed by Mr. Kates.

MR. KATES. —A study might show the government to what extent different transportation systems affect one another and therefore to what extent such a central agency might be necessary. To that extent such a study is needed.

The argument about accuracy is of interest. I gather from Dr. Carroll's remarks about the inaccuracy of various models that he is concluding that we are in trouble.

However, for many economic methods a great deal of accuracy is really not necessary. One must simply show, roughly, directional movements and the relative order of magnitude of what to expect—the movement in one direction or another. For instance, in a number of studies made on pipelines, railways, etc., extremely little accuracy was required to show what effect on railway rates would have in dividing the traffic between the railways and other carriers and what the railway industry and the oil industry should do to avoid increasing transportation costs. We do not have to worry about 20 or 30 or even 40 percent precision.

As a matter of fact, with these large-scale economic studies, which deal with the economy as a whole rather than with fine details, one is much less subject to statistical error.

CHAIRMAN HANSEN. —In support of that point, the graphic material presented earlier in this discussion showed a rough cut at what has been discussed here, and would certainly be of interest to this group, however crude.

MR. DAVIS. —We are not in a position at present to design a national transportation study having the dimensions that have been alluded to here. Many of us sense that in the future this will be possible, but to start thinking about it is imperative, and that is what this meeting is about.

Perhaps a more limited objective, maybe within the Highway Research Board, through cooperative effort of some of the committees, would make possible the development of a prospectus in somewhat finer detail than has been possible here today. We could then argue the justification of whether this part is good or this part is useless.

There might be a period of a couple of years in which the question of what constitutes the useful dimensions of such a study might be discussed.

MR. TOMAZINIS. —There is one good objection to the approach suggested by Mr. Kates. We might be in a better position if we do not approach the problem having in mind only cost and time, a very limited objective.

This might turn out results which could be unrealistic and would be rejected outright as erroneous by many groups in the country. But if the problem is approached with a much larger objective first, and if we outline the areas in which we can go further (if we explicitly outline the means of accomplishing it, if we project what is possible to be projected), then we might be more honest with ourselves and others and would be able to persuade more people, including decision makers.

It has possibly been the tendency of some people to take the easiest way out and, after forming a set of all-inclusive and over-simplified assumptions, to derive conclusions rapidly. In a couple of years most people forget what the original assumptions were and only remember the conclusions. I am afraid that the strategy proposed by Mr. Kates might lead to such a segmentation of the analysis and over-simplification of the problem. It seems the reverse of what was suggested by Mr. Kates might be the best approach to such a study.

MR. KATES. —Mr. Tomazinis apparently has misunderstood: the example I mentioned was cost and time. But what I was shooting for was separate studies in two parts, one providing a basis for national policy without going into detail, and a second providing the basis for design policies for railways, highways, etc. The example given had only two variables, but this was only to make a point.

I agree with him that other variables which have a significant effect on results should be taken into consideration.

L. M. CLAUSON, Chief Engineer, Iowa State Highway Commission, Ames, Iowa (written comment). — Presently, Iowa, together with ten other midwestern states, is awaiting the results of a rural regional origin-and-destination study. The data collected by the eleven-state group is being analyzed by the Bureau of Public Roads for the regional movements. Each state will analyze its own intrastate movements. A similar study should be undertaken in other regions of the United States and later these data from each of the several regions should be correlated with the others.

A study of this nature can provide data for development of transportation facilities which would augment the Interstate Highway System. Private industry should at the same time undertake a similar study that could be correlated with a study of highway needs to provide a complete solution to the over-all problem of transportation.

The know-how of the collection and analysis of the necessary data is available; however, implementation of results of such a study is not available, both as to finance and desire. The recommended solutions should be practical and within an attainable period of time.

WILLIAM R. McGRATH, Director, New Haven Department of Traffic and Parking, New Haven, Conn. (written comment). — The intercity transportation study described in the advance material would undoubtedly be of great value, particularly in formulating over-all national transportation policy. The study will need to be broad enough to make it possible to finish the job, yet with enough detail to provide knowledge of the major travel desires by modes and the means of projection. We probably have sufficient knowledge in the field now to select the correct data collection method and carry it through, but additional research in advance and throughout the study might be needed to determine the best analyses.

Any attempt to patch together results of the many studies of all sorts that have been made all over the country would not be worthwhile other than for the familiarity gained by review. A committee could not undertake a study of this magnitude; it would have to be put forth by some major organization of national scope, such as the Highway Research Board itself, or a special project of the U. S. Bureau of Public Roads, or a Congressional committee. There is no doubt that a large expenditure would be required in the long run.

I foresee a data collection effort similar in magnitude to parts of the census. In fact, the U. S. Census Bureau could perhaps help develop procedures. A direct interview sample spread throughout the entire country might well be the best source of information. Probably it could be handled through the state highway departments. Possibly the HHFA could cooperate with transit study funds, which might be available.

Arbitrary zoning or exclusion of trip areas or persons on the basis of low land use, density, or whatever, would tend to discard in advance much valuable information that might be gained in such a study. Perhaps, instead, it would be possible to develop computer techniques to be operated directly on sample data against control statistics such as land use, density, and so on, and that such computer work might produce guidance for proper zoning and grouping of information.

JAMES S. BURCH, Planning Engineer, North Carolina State Highway Commission, Raleigh, N. C. (written comments). — The justification for such an enormous study is one which cannot be perfunctorily assumed by this committee. Its magnitude and importance is one justifying careful consideration by the Board itself. It should be stressed that all forms of transportation—highway, rail, water, air, pipeline, etc.—are encompassed.

It is apparent that the highway organizations should not be expected to conduct such a voluminous study alone. Although available data do not permit a comparable common denominator of "transportation," it is likely that the motor vehicle accounts for a major portion of passenger vehicle-miles, but a minor portion of ton-miles of movement of goods (even though the vast majority of products use trucks at one or more stages in the industrial production line from raw materials to the ultimate consumer).

It would appear that such an herculean and all-encompassing effort could only be approached by the formation of a national committee, made up of a score of competent,

experienced, full-time directors, each drawn from an organization having long experience and voluminous data related to his own phase of transportation (rail, street, highway, air, pipeline, truck, river, canal, maritime, coastal, etc.)

Such men—carefully selected and on perhaps a five-year leave of absence from their present organization—working full time with adequate staff, space, and budget, could assemble, analyze, assimilate and develop the necessary guides in the problem, each calling on branches of his organization to assist in obtaining and supplying basic data.

Although Federal financial support would be appropriate and necessary, other sources of support could and should be solicited and received. The Highway Research Board, under the National Research Council, would be an appropriate parent organization, acting in somewhat the same capacity as in the Illinois Road Test project.

The study itself should not be Federally controlled or directed, to avoid the inevitable accusations of lobbying, party politics, concealment of facts, favoritism toward vested interests, and the like. This, however, would not preclude the service of competent leave-of-absence Civil Service technicians or directors on the research project.

The conduct of the study should avoid the philosophy of complete Federal control of transportation, being limited to that now necessary to avoid monopolies, protect the public interest, etc., as now covered by law. The study should be factual and should be directed toward recommendations to improve services and efficiency, and to lower costs, without excessive new Federal controls, or loss of competition based on private initiative and the profit motive. That this will be difficult is readily admitted. That the basic philosophy be predetermined is, however, of paramount importance.

The magnitude of the undertaking is surely much too vast for active sponsorship by this Committee, or even by the Department of Traffic and Operations. It will have to be a separate, large, and full-time group made up of a large number of competent, experienced directors, operating directly under the Board itself.